

IUE Spacecraft Battery Management:  
New Policies Governing IUE Science Operations at Power-Negative Attitudes

The IUE Project Operations Director recently issued a new Flight Operations Directive (FOD) governing use of the spacecraft's batteries at attitudes at which the solar arrays produce insufficient power for normal operations. (Such attitudes are referred to as power-negative attitudes or power-negative beta angles.) This FOD is a result of laboratory studies using batteries identical to those on the spacecraft. The studies addressed the aging characteristics of the batteries when subjected to repeated charge/discharge duty cycling under relatively low loads. The purpose of the FOD is to preserve the batteries, to the greatest practicable extent, for use during spacecraft shadow seasons. During these semi-annual seasons, each lasting several weeks, the spacecraft experiences daily occultations of the sun by the earth. During these occultations the batteries are necessary to sustain the life of the IUE.

The new FOD restricts to 36 the number of times per year that either spacecraft battery may be discharged below 22.5 volts during non-shadow operations, and to 12 the number of times per year that either battery may be driven to one of its "red line" limits. (When a red-line limit is reached immediate recovery action becomes mandatory.) In terms of battery lifetime these numbers equate to roughly one-half of a shadow season of use per year. The discharge cycle allocations have each been divided 2:1 between NASA operations and ESA/SERC operations.

The IUE Observatory believes that it can reduce the impact of the FOD on science operations through careful scheduling of each program. To be successful the scheduling activity will require the cooperation of Guest Observers in making known the priorities of their targets at the beginning of the observing episode. The FOD may occasionally necessitate that a program's allocated observing time be split into more observing runs than would otherwise have been required. [The Observatory has considered the possibility but does not believe at this time that some integrated scheduling (rather than block scheduling) of programs is either necessary or decidedly advantageous.]

In order to implement the FOD the Observatory has developed a set of guidelines under which it will allocate and track power-negative operations. Two principles govern these guidelines. First, the FOD sets limits on battery use; it does not advocate using the batteries to the maximum extent permitted. Second, some flexibility must be reserved for unpredictable operations; e.g., those involving Targets of Opportunity. Both principles are consistent with a conservative application of the guidelines.

It is impossible to define two exact beta angles above and below which power-positive or power-neutral operations cannot be conducted. The power budget of the spacecraft is a function not only of beta angle, but also of time of year and spacecraft configuration. Each potential excursion to high or low beta must be evaluated in terms of length of stay, camera cycling requirements (exposures, reads, preps), spacecraft heater

requirements and other factors. Thus, an observer wishing to operate outside of the range  $25^\circ < \beta < 115^\circ$  will be expected to discuss his/her observational needs with an IUE Resident Astronomer on a case-by-case basis. Generally, this must be done in advance of the scheduled observing run. The RA will use up-to-date information and expertise to judge the likelihood that a proposed operation will result in a crossing of a battery voltage threshold. Subsequently, two rules will apply: (1) Operations certain to discharge a battery beyond the 22.5 volt threshold will require approval; (2) Operations at attitudes which are power-marginal will be permitted if the spacecraft can be configured to ensure its operation in a power-positive or power-neutral manner. It will be understood, however, that the RA may terminate an operation prior to its nominal completion if it lacks a "threshold authorization" and is found to be driving a battery towards a threshold.

The Project's intent is to continue its policy of providing GOs with the maximum degree of flexibility consistent with rules necessarily imposed on the operation of the IUE. GOs can expect to minimize the impact of these power constraints on their science programs by providing the Observatory with timely information on the priorities assigned to the program's targets. The guidelines which follow convey the Observatory's planned approach to utilizing its allocation of power-negative operations. An algorithm for calculating target beta angles is described in the "IUE News" contribution by Cathy Imhoff.

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October 28, 1983