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## ASTROTECH -- STREAMLINING PAYLOAD PROCESSING OPERATIONS

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### ABSTRACT

The Astrotech experience offers clear evidence of the ability of the commercial sector and NASA to work together with close and continuing cooperation to the mutual benefit of not only Government and Industry, but also the launch customer and payload manufacturer communities. Astrotech was able to take advantage of twenty-five years of payload processing experience by others to design and build a conterminous, state-of-the-art payload processing facility. While payload processing is only one part of the total launch operation, the availability of adjacent nonhazardous and hazardous facilities and the demonstrated flexibility of a commercial operator to respond to the unique processing requirements of the individual payload customer and manufacturer serves to facilitate and thereby streamline this portion of the ground operations.

### AN OPPORTUNITY WITH WELL DEFINED REQUIREMENTS

The last twenty-five years have seen the evolution of the space program from that of a Government sponsored and dominated program primarily serving Government interests to that of a program with increasing opportunity for and dependence upon commercial activities and involvement. The increase in spaceflight activity through expanded use of telecommunications and earth imaging satellites and the development of materials processing and other space-based manufacturing payloads, coupled with the increased launch rate capability offered by the Shuttle and potential commercial Expendable Launch Vehicles (ELV's) resulted in, among other things, the need for expanded launch site payload processing facilities to accommodate the corresponding increase in payload preparation activity.

In late 1984, Astrotech welcomed its first processing customer to the United States' first commercially operated payload processing facility. Located two miles west of the

Kennedy Space Center (KSC) and known as "Astrotech TICO", this facility blends the approximately twenty-five years of NASA, customer, and manufacturer payload processing experience at KSC with a new, state-of-the-art processing facility. In addition, to drawing extensively from the NASA and USAF safety policies and criteria, Astrotech TICO was built and operates in conformance with all applicable Federal, State, and Local environmental and safety regulations and requirements.

Within the first year of operation, Astrotech Space Operations, Inc. successfully demonstrated the ability to segregate payload processing activities from the overall launch operations ground flow by supporting all or part of the preparation of ten commercial communications satellites and their perigee kick stages. A significant reason for the early success of the Astrotech payload processing operation was the fact that payload processing was one area of the Expendable Launch Vehicle (ELV) experience that was directly applicable to the Shuttle Program. Although there are some differences between the prelaunch preparations for ELV and Shuttle payloads, these differences tend to be more schedule related than technical. As a result, payload processing requirements are both well defined and well understood based on many years of relevant experience.

### CHALLENGES OF COMMERCIALIZATION - WORKING WITH THE GOVERNMENT

The arrival of Astrotech's first payload processing customer in December 1984 marked the end of a more than three year business development process which proved much more challenging and difficult than initially anticipated. There were several key factors that spelled the difference between failure and success of this venture. Following his extensive NASA career in the Delta ELV Program, Robert Goss, President of Astrotech, first conceived the idea of developing a commercially operated payload processing

facility in late 1980 and formally approached NASA with a preliminary overture in mid-1981. This was about the time NASA facility planners were beginning to focus on the need for expanded payload processing facilities to keep pace with the projected increased payload launch rate planned with the Shuttle.

The initial response from NASA was one of cautious optimism. While the need for additional facilities was clear, it was unclear to NASA just how to integrate a commercially operated facility located outside of the confines of KSC into the overall KSC facilities planning and operations. However, through the diligent efforts of Bob Goss with several others on the Astrotech staff and a dedicated group of NASA officials, together they began to chart a course that would retain the commercial separateness and viability of the Astrotech TICO operation, while providing NASA with the assurances necessary to a Government Agency. The result of these efforts was development of a Memorandum of Understanding (MOU), which was ultimately signed in April 1984 and is the cornerstone of the NASA/Astrotech relationship.

The NASA/Astrotech MOU recognizes the mutual benefits to be derived from this relationship and identifies the commitments to support each other's operations. Specifically, under the MOU NASA agrees to provide certain supporting services to customers using Astrotech TICO on a fully reimbursable, noninterference basis. These services are limited to those support items where there was either insufficient combined requirements to justify a separate commercial source or where there was no commercial source available (e.g.- liquid & solid propellant short-term storage, rocket motor cold soak and X-ray, and hydrazine chemical analysis). In return, Astrotech agrees that NASA shall have "march-in" rights to takeover, at Astrotech expense, operation of Astrotech TICO, if Astrotech fails to provide payload processing facilities and support in a manner that jeopardizes the launch schedule. In addition, if Astrotech ever chooses to sell the Astrotech TICO operation, NASA shall have the first right of refusal to purchase or otherwise obtain the facility.

There was little Government guidance available at the Federal, State and Local levels in the form of criteria and guidelines for the design and operation of a facility such as that envisioned by Astrotech. While there was applicable material and advice in such areas as restrictions on the handling and use of radioactive and toxic materials, only NASA and USAF had relevant experience in the design and operation of payload processing facilities. Therefore, the design and operation of Astrotech TICO drew extensively on the combined NASA and USAF experiences. Under special arrangement with NASA, Astrotech was able to draw directly on the expertise of key NASA/USAF safety officials to review and

comment on the proposed facility design to verify that the tradition of safe facility operation would continue at Astrotech TICO.

#### CHALLENGES TO COMMERCIALIZATION - FINANCING

Astrotech initially arranged for construction financing for the facility through a group of local Maryland investors, who had no previous aerospace related experience. When the time arrived for the ground breaking ceremony, they announced a halt to further funding until Astrotech could produce a "signed-up" customer. While this might not have seemed unreasonable for a traditional commercial venture, it was clear to Astrotech that one could not expect to sign-up customers until one had a facility which they could inspect. Pictures and drawings just wouldn't sell when acceptable NASA facilities were still available. At that point it appeared that the dream of an Astrotech facility had encountered an insurmountable obstacle. However, through a chance meeting with Willard (Al) Rockwell, Jr. and The Cyprus Corporation (later renamed Astrotech International Corporation), Bob Goss was able to arrange the sale of the original financial group's interests in Astrotech to Mr. Rockwell. Once this was accomplished, funding was secured in the form of an Industrial Revenue Bond held by the Barnett Bank of Florida and construction commenced, to be fully completed ten months later.

#### CHALLENGES TO COMMERCIALIZATION - CUSTOMER ACCEPTANCE

Still another key factor to the success of this venture was maximizing the assurance of customer acceptance of a commercial payload processing facility. This was accomplished in part by involving the prospective early customers and their manufacturers in the design of the facility by soliciting design suggestions based upon their experiences. Beyond this was the need to overcome a traditional mode of operations. Although the payload manufacturer would continue to perform the "hands-on" activity associated with the payload processing, the tradition has been and all current payload contracts specify that the launch customer is responsible for arranging for the use of suitable launch site facilities by the manufacturer. This tradition necessitated the careful orchestration for simultaneous customer and manufacturer review and acceptance of the Astrotech operation.

While all of these considerations were important to obtaining customer commitments, ultimately the customers had to be assured that use of Astrotech TICO would be both attractively priced and not increase their program risk. In assessing the risk element, the MOU was essential, since it conveys to the customer community NASA's overall interest and concern for the successful operation of Astrotech TICO. This impression that the NASA "umbrella" encompasses Astrotech TICO operations was extremely important to the

'success in obtaining commitments from early customers to use the facility. These risk concerns were only resolved through the positive assurances by NASA, reinforcing the intent of the MOU.

Since Astrotech TICO is located off the Federal Reservation, another question which surfaced with prospective customers was concern about any adverse changes to their State and County tax liability resulting from locating their payload processing activities at Astrotech TICO vis-a-vis KSC. In general, both the State and County have made efforts to provide favorable tax conditions in order to encourage companies such as Astrotech to locate in Florida. Following consultation with both State and County tax authorities we ascertained that the customers' tax liability at Astrotech TICO was virtually unchanged from that at KSC.

#### THE RESULTS

Astrotech TICO embodies both the processing capabilities that customers have grown to expect over the years from the similar KSC facilities, and some expanded capabilities that in the past customers have either had to seek outside of NASA or have had to do without. The service and support offered by Astrotech is comparable to that available when using the NASA facilities. Customers and manufacturers generally establish their own payload processing schedules, driven primarily by the NASA specified payload delivery date to the KSC Vertical Processing Facility. To support this flexibility, Astrotech offers to support payload processing activities up to 24 hours a day, with the attendant reduction in the overall launch campaign.

Currently Astrotech TICO consists of five major buildings located on approximately one-third of the 40 acre complex. The land, construction and facility equipment represent a total investment to date of \$9.5 million. Following is a short tour of Astrotech TICO.

#### NONHAZARDOUS PROCESSING AREA

The largest building on the site and the one that is emblazoned with "ASTROTECH" is the Payload Processing Building wherein all nonhazardous payload assembly and checkout occurs. This building is similar in purpose to the several NASA Hangars at the Cape Canaveral Air Force Station (CCAFS). In addition to the Astrotech offices and conference room and snack room facilities, this building contains three separate, but virtually identical processing areas. Each processing area consists of a 40x60 foot high bay clean-room with a 10 ton overhead bridge crane (37.5 foot hook height), two adjacent control rooms, and contiguous manufacturer office space. The three high bays are linked by a common 30x120 foot airlock. All high bays and the airlock are designed to maintain Class 100,000 cleanliness, but in fact can

maintain Class 10,000 under strict operating conditions.

This building also houses the communications links between Astrotech TICO and the launch site (KSC or CCAFS). Astrotech offers customers the full range of communications links generally employed in payload checkout and launch activities. These include C-, S- and Ku-band RF links, wide band data and video links, and voice communications (via four-wire links between Astrotech and KSC, two-wire links within Astrotech TICO, or commercial telephone). Although a payload is only present at Astrotech TICO for approximately one-half of the launch campaign, the payload ground station and work base for the customer and manufacturer staffs remain at Astrotech TICO for the duration of the launch campaign, typically 12-16 weeks.

Several unique features were incorporated into this building as a result of NASA, customer and manufacturer suggestions. Each control room is isolated from the adjacent high bay clean-room by a wall containing a large plate glass window with a voice diaphragm and separately air conditioned. This enhances maintenance of the clean-room environment by removing the ground station heat load from and reducing the number of people in the controlled area. Also, the ability to have both visual and spoken communications avoids any compromise in operational convenience. Similarly, the manufacturer office area which is located on the second floor of this building has large windows overlooking the high clean-room and voice communications to permit monitoring and active participation by personnel in the office area. The South high bay contains an RF transparent window which looks out on a far-field antenna range that was provided in response to one manufacturer's requirement for this capability. And especially for European programs, Astrotech offers the option of 50 Hz facility power for ground stations and equipment built to European standards.

#### HAZARDOUS PROCESSING AREA

The second largest building is the Final Assembly Building wherein all hazardous operations, such as liquid propellant fueling and solid propellant rocket motor preparations, are performed. This building is similar in purpose and external appearance to the several explosive safe areas currently in use at KSC and CCAFS, and also features three high bay clean-rooms. The building construction and electrical equipment in all three high bay clean-rooms fully meets all accepted explosion-proof standards and was designed to accommodate the height requirements associated with Centaur fairing encapsulation. The two 37x60 foot high bays at either end of the building are virtually identical and include 25x25 foot fueling islands which are connected to the toxic waste containment system at the rear of the

building. The North high bay and adjacent control room complex provide a hazardous processing area suitable for spacecraft or upper stage preparations. This area is currently dedicated to the McDonnell Douglas commercial PAM processing activities. The South high bay and adjacent control room, oxidizer cart storage room, and fuel cart storage room provide the hazardous processing area which is currently being used for spacecraft activities. A 29x38 foot airlock provides environmentally controlled access to the building through the South high bay.

The 27x48 foot center high bay houses an 18,500 pound capacity dynamic balance machine. This dynamic balance machine is installed below the floor level so that, when not in use, removable deck plates can be installed to make the center high bay available as an additional hazardous processing facility suitable for ordnance activities.

Here again, several unique features were incorporated into this building as a result of NASA, customer and manufacturer suggestions. As mentioned above, a large fueling island is provided, which offers added flexibility for fueling operations. The floor covering in all areas of the high bay clean-rooms is electrically conductive, avoiding restricted work areas that have occurred where only localized conductive flooring was available. A large, one inch thick "bullet-proof" glass window is embedded in the solid concrete wall between each end high bay clean-room and its adjacent control room. The location of this window immediately adjacent to the payload work area enables the safety and quality assurance personnel who must be present for all payload work to remain in the control room, outside of the hazard area, without compromising the safety or quality of the tasks performed. The 10 ton overhead bridge crane system (also with 37.5 foot hook height) was designed so that, while each high bay clean-room has its own bridge, only one trolley exists and is capable of moving from one bridge to another. This permits the transfer of payload hardware from one high bay to another with a single lift operation, thereby providing for more efficient, lower risk operations.

#### PAYLOAD STORAGE

The third major building is the Payload Storage Building, which is comprised of six individual, secure, and environmentally controlled bays for storage of spacecraft, upper stages, or completely processed payloads awaiting transfer to KSC. Each storage bay is approximately 22x25 feet in floor area with a clear vertical height of 28 feet. The individual bays each have their own air conditioning and humidity control system, cross-strapped with that of an adjacent bay for redundancy. A clean-room environment is not available in this building. Approximately one-half of this building is available for

long-term spacecraft storage, while the remainder is reserved to support processing activities.

This storage building was largely the result of NASA, customer and manufacturer suggestions, spawned by the fact that no similar capability for payload storage existed at the launch site. Because of the favorable inventory tax situation in Florida, the addition of the Astrotech expertise for monitoring the storage, and attractive storage rates, considerable interest for use of this capability has been expressed and, in fact, we had two storage customers during the first year of operation.

#### WAREHOUSE STORAGE

The fourth major building is the 50x125 foot Warehouse Storage Building which, while not environmentally controlled, provides "out-of-the-weather" storage for shipping containers and large ground support equipment associated with payload processing activities. With a floor area of over 6000 square feet and a clear ceiling height in excess of 20 feet, this building provides adequate shared storage space to support 3-4 parallel processing activities.

This building was designed and built over a three month period in late 1984 in direct response to the suggestions of the initial manufacturers who had committed to use Astrotech TICO. They observed that since their shipping containers and large ground equipment could not be stored outside, the only alternative was to keep these items in the processing areas when not in use, as had been their practice at KSC. By making use of this warehouse storage capability, the manufacturers have been able to remove clutter and thereby improve payload processing efficiency.

#### CUSTOMER OFFICE AREA

The fifth major building is the Customer Office Building which contains 17 individual offices (each capable of accommodating two desks), two small meeting rooms, and a reception area capable of accommodating three receptionists. This building is placed adjacent to the Payload Processing Building and provides the base of operations for the customer staff present during a launch campaign. As a shared facility, each customer is allotted 3-5 offices and a receptionist area. Based on the experience of the first year of operation, this building can comfortably accommodate up to four customers simultaneously.

Here again, this building was the direct result of customer and manufacturer suggestions. The one consensus opinion we received from the customers and manufacturers was the desire to be close to each other, but not to cohabit the same office area.

## OUTLOOK FOR THE FUTURE

During the first year of operations 85% of all commercial payloads launched on the Shuttle were processed at Astrotech TICO. While we had been hopeful for such initial success, the Shuttle manifest clearly had shown for some time that the years 1986 and 1987 would be much slower due to the reduced number of commercial payloads scheduled for launch, but that commercial payload traffic would again pick-up in 1988. Of course we could not anticipate the CHALLENGER accident, which has brought all launch operations to an indefinite halt. While such a hiatus tests one's ability to survive, this is one of the risks that must be taken into account with new ventures such as space commercialization, and we expect to survive intact.

During this period we had been planning (and continue to plan) for the next phase of facility expansion. While the Astrotech TICO facility, as it exists today, has been able to handle the majority of the commercial traffic on the Shuttle in 1985, it is not currently capable of supporting all commercial payload processing activity. To accomplish this will require the addition of larger facilities capable of satisfying the requirements of any payload able to be flown aboard the Shuttle. In addition, several of the materials processing and life sciences payload programs that are currently under development will require additional specialized facilities, some of which are not currently available in the KSC area. It is the desire and intent of Astrotech to prepare to meet these demands, as they become reality.

In this regard we invite those who foresee future launch site facility requirements to contact Astrotech, so that together we can continue preparing for the future. We are happy to be able to serve our present customers and we are excited about the prospects for the future. We look forward to the opportunity to continue our close relationship with NASA in serving the growing commercial space community.