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## Paper Session I-C - Concept of Operations: A Model for Commercial Launch Site Support

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**CONCEPT OF OPERATIONS:  
A MODEL FOR COMMERCIAL LAUNCH SITE SUPPORT  
BRUCE A. BJORNSTAD**

The reality of increased access to space for the commercial launch industry is that existing sites must foster an environment which is capable of compromise, responsive to the customers needs and allows the customer to maximize their launch capabilities.

The Commercial Space Launch industry has become a highly competitive multi-billion dollar industry. Much has been done and written concerning launch vehicle design, production and processing and the steps that have been taken to reduce their costs and increase their commercial market share. However, very little has been documented as to the process renovations which the launch sites are going to have to under go due to competition between the various foreign and domestic launch sites which are just beginning to develop. With new spaceports springing up all across North America (e. g. California, Florida, Virginia and Alaska) and overseas ( e.g. Russia, Canada, China, Ukraine) looking to capitalize on this new and growing market, the reduction of support cost becomes a pressing issue.

The by-product of this increased competition is that the launch site operators are beginning to understand that dramatic change can and must be made in support areas in order to reduce launch site costs and increase efficiencies. In such areas as the launch pad and launch processing support efforts, this becomes critical to remaining a viable commercial launch site. It is becoming mandatory that site personnel begin to focus their attention on understanding the customer and his requirements, increasing facility system reliability, and driving down launch site costs.

The initial action taken must be an in-depth review of all launch processes and an aggressive elimination of all non-value added processes and activities. The emphasis must shift from the current concept where the launch user is required to absolutely conform to the existing launch site system for doing business. The new culture must reflect a dynamic operation in which the system is capable of compromise and responsive to the needs of the user. Site management must be willing to support the user and allow him to maximize his launch operations capabilities.

Focusing on customer requirements at the launch site means the site operator must take the necessary steps to understand and become actively involved with the launch customer and his requirements. It means the site operator must cultivate and nurture a customer oriented environment in which the customers needs must receive primary emphasis. This ranges from personnel interactions to standardization of interfaces, personal and mechanical. In the briefest of terms, it means, accommodation of the launch user rather than the launch user accommodating the site. After all, the user has other launch site options available to them.

In the model system, the launch site operator will take the lead in coordinating the interfacing of all requirements for the launch user. This requirement can be performed by an organization of site liaison personnel to serve as an extension of the launch user, vice the launch site. This organization would have to be well versed in all facets of site

operations and would begin to work with the launch user during the conceptual and design phase, continue through the development of program documentation and through actual operations and post launch data support. This group would provide a single point of contact for all launch support operations. The individuals in this organization would provide an interface for all programmatic requirements including; risk analysis, configuration control, design reviews, and preparation of compliance documentation. They would also ensure required resources were available for each key task from submittals into the Universal Documentation System or similar systems for other launch sites, to arranging for transportation of the vehicle upon receipt and to providing support from booster processing through stacking and launch. This approach would also include regular reviews ensuring that all parties have visibility into launch status, documentation of tests and launches for analysis, and integration of the launch into the overall site launch schedule. This proven methodology provides the user a structured path for taking the launch vehicle from delivery through launch.

The key specific responsibilities which this organization would provide and oversee for the launch user include;

1. **Planning** - The organization would develop and provide a launch test plan, specifically designed for each launch user, which would define the procedures, responsibilities and methods to be employed to assure the flight readiness of the launch vehicle, Ground Support Equipment and associated facilities. The primary objective of this plan is to achieve the mission objectives through assurance of maximum system integrity and readiness. The plan would provide the processes to be used in establishing technical readiness and would describe the major technical milestones and managerial reviews required. These reviews provide for the monitoring, measurement and assessment of the work functions ensuring mission readiness. This process allows the launch organization real time visibility and review of the systems and procedures necessary to receive, process, administer, plan, document and execute the management and control of resources during all phases of program support. It also applies established performance metrics, integrated into the plan and measured through the schedule, showing effective control and use of equipment, hardware and software from inception to implementation.
2. **Scheduling** - The agency will develop fully integrated schedules; identifying critical timeline milestones and accommodating impact analysis, program additions, deletions or changes. The schedule reflects a detailed knowledge of instrumentation, facilities, data and methodologies for assessing schedule implications of varying equipment status. These schedules fully define status requirements and availability. Schedules will reference back and highlight the launch processing instructions which provide details for each major milestone in the processing flow. These instructions are designed to minimize processing/integrating times and will specify the type and number of personnel required and the tasks and sequence in which they will be performed. The integrated schedule includes all operational milestones, highlight any potential conflicts and ensure that all critical elements are addressed. The master schedule will be developed at the daily

scheduling meetings with all major agencies to discuss previous day's activities and to provide an integrated schedule at levels of detail relevant to the activities to be performed in the near future. These detailed and short-term schedules will be tracked by and support the Critical Path schedule developed in the origins of the program. It is the purpose of these meetings to ensure all personnel and organizations receive current information and this information will be used to deconflict scheduling conflicts between the parties.

3. **Critical Path Management** - The interfacing organization provides the focal point for managing activities in accordance with the critical path. This responsibility includes coordinating exchange of information between the interfaces, collecting daily feedback from operational elements and incorporating this into the master schedule. The process will involve the review for impending conflicts or resource application difficulties, updating of the master and sub-schedules and the timely dissemination of that information to process participants. These schedules will track the critical path on a real time basis. This will allow for the identification of problem area potentials or perturbations and allow for real time adjustments. This office will also prepare cost schedule performance analysis and summaries for review and discussion. They will prepare the necessary performance risk analysis and mitigation recommendations along with the anticipated impact to performance, cost and schedule, thus enabling the team to discuss previous problems, potential bottlenecks or conflicts and to resolve those issues prior to them impacting the launch flow.
4. **Technical Control** - The organization will be responsible for assessing all launch risks and providing alternative solutions, costs and schedule impact to mitigate risk. This organization will oversee the configuration management process as it pertains to the launch site systems ensuring minimum interface difficulties with user systems. The configuration management will assure optimized standardization and reliance on Commercial-Off-The-Shelf (COTS) items minimizing cost and equipment interface changes. This organization will also serve as a focal point for all system modifications and ensure that the launch user's requirements are presented at all design review meetings and that the launch user is kept informed as to the status of all system modifications.
5. **Cost Control** - Cost control implementation must be fully integrated within this organization. Positive program cost control will be maintained through a continuous program of expenditure and budget reviews with assigned accountability and responsibility tracking. As schedules and costs are reviewed any excursion from the plan will be highlighted and the necessary corrective actions required to regain the schedule track. Through this application of firm, positive, control of expenditures, an immediate visibility of budget status can be obtained.

As can be seen by a review of these responsibility areas, the launch site will have to assume the integration responsibilities for the user and provide many of the services which in years past the launch user would provide, with a larger than necessary administrative workforce and support budget. The commercial customer will not

support these larger workforces and their operating budgets will be much smaller driven by the profit motive and competitive constraints. The implementation of this type of a program at the launch site will provide the necessary information to the launch organization to launch but will relieve them of the necessity of having to learn and coordinate with the detailed interfaces of the launch site. This approach effectively shifts the launch integration responsibilities from the launch user to the launch site. This shift of responsibility is needed for two reasons: first, the launch site operator better understands the interfaces and the requirements necessary to meet the mission standards, and can accomplish them more efficiently and secondly, there is no value to the launch user in acquiring this knowledge.

Along with developing an understanding of the launch customer and his requirements the launch site operator must review and improve its facility system reliability processes. This becomes necessary in order to reduce overall facility maintenance costs, decrease facility downtime and thus as a by-product increase overall mission success reliability. The main focus of improving the facility system reliability process requires a shift to a comprehensive integrated operations and maintenance philosophy; and will involve more than the individuals which actually perform the maintenance and repairs.

This philosophy implies a culture and atmosphere focusing on continuously improving the maintenance program and improving equipment efficiency while optimizing overall costs. This concept builds on techniques which have already been developed and are currently being implemented. It seeks to capitalize on those functions which the organization does well and integrate all organizations, functions and people to focus on one common goal, and that is to optimize the maintenance program. The specific goal is to have every department; work control, engineering, logistics, maintenance, configuration management and other functional elements or activities involved in making the maintenance program the best it can be.

The foundation of this sound maintenance concept includes an integrated maintenance program. Development and implementation of the integrated program applies processes which provide operators and maintainers with a fully integrated maintenance program for each critical equipment item which is operated. Analysis will be conducted using applicable reliability centered maintenance techniques to establish a baseline for each item. Integrated maintenance introduces a proactive approach. The goal of which is to ultimately culminate in a maintenance program based on an informed decision process. This integrated approach applies an optimum mix of reactive, recurring, and predictive maintenance. To the maximum extent feasible, within reasonable fiscal constraints, predictive methods and technologies will be integrated into recurring preventive maintenance activities, to further optimize the system efficiency and reliability of critical systems.

The specific advantages of this type of an approach are that it involves total participation of all parties taking an active role in determining and implementing the optimum maintenance process. It requires active operator involvement, building on the knowledge and experiences already in place. The primary emphasis is on failure

prevention, intervening prior to equipment failure, based upon an informed knowledge of the items operating condition, and improving the maintenance activities with the end result of maximized equipment efficiency. This proactive approach uses reliability and condition centered maintenance as a baseline technique and then integrates various maintenance technologies to obtain the optimum mix of economy and efficiency.

This could range from the reactive maintenance technique of “Run to Fail” meaning we will only fix it when it breaks; through the traditional recurring maintenance techniques such as audio/visual checks, lubrication, scheduled maintenance and equipment inspection; up to application of predictive maintenance techniques such as vibration trend analysis, ultrasonic detection, thermography and spectrography. Tools such as these, properly applied, assure maximum safety, reliability, and operational readiness for a pad or processing facility. Proper application and analysis of these processes indicate impending system failures in the early stages in critical facility hardware, reducing failure potential during critical operations. This process is designed to detect and correct these impending problems before they become costly catastrophic failures or schedule impacting anomalies. By taking advantage of state-of-the-art maintenance techniques and accurately forecasting the labor and material resources required to repair the problem, we will be able to increase mission assurance confidence, optimize equipment life, reduce facility downtime, devise work arounds for operational requirements, stage parts in advance of requirements and provide accurate risk assessments.

Beyond comprehensive operations and maintenance, the next area which must be addressed is overall launch cost reduction. While the previously discussed areas, the liaison office and total productive maintenance, will have the overall effect of reducing launch costs to a certain degree, other positive, aggressive steps will have to be taken in order to provide the most competitive price. Among these are; Improved Workforce Utilization, Just-In-Time material delivery techniques and materials standardization.

In the area of improved workforce utilization it is critical to change the existing practices, in place at many existing non-commercial launch sites, requiring a committed standing workforce regardless of the launch activity. New commercial customers will not fund these requirements and most of their requirements will be directed toward a single launch not long term launch program requirements. Instead the launch site will be forced to provide a skilled and qualified workforce capable of expanding and contracting to the surge requirements of the launchers schedule. After launch as post launch refurbishment phases down the workforce will adjust in order to minimize direct costs to the commercial customer. As the number of commercial launches increase the workforce size may become relatively stabilized but may have to shift among multiple launch sites in support of multiple customers. This flexible workforce and the requirement for reducing costs, will necessitate the liaison office to implement an accurate and dynamic scheduling and cost tracking process to ensure maximum efficiency of resource utilization is achieved. This ensures the launch customer is provided the visibility and workforce responsiveness necessary to support the launch process, even if unplanned situations or problems arise.

Beyond the efficient application and utilization of the mobile workforce, the launch site must also review and optimize existing material acquisition processes. Current acquisition practices dictate a large capital investment in a relatively static inventory. As a result of these current practices, material delivery timelines for items outside this inventory will be totally unacceptable to the launch customer. The process necessary to alleviate this situation is to adhere to a Just-In-Time (JIT) material receipt system. Implementation of a JIT system would require little or no investment tied up in inventory and the site would benefit itself and local merchants as common material requirements arise. A mutual benefit to the Launch Customer and local economy is realized through local purchase of common, off-the-shelf materials while minimizing capital committed to non-value added processes concurrent with a high confidence level of material on-time delivery. Another factor which must be implemented within the logistic area is the standardization of materials which are used within our launch facilities, and a shift to common off-the-shelf (OTS) material. Currently, many items are unique one-of-a-kind, or "built-to-specification" items. The immediate shift away from the mindset that says each launch/site/facility is "unique", is crucial to driving launch costs down. Continued reliance upon individually manufactured equipment items and non-standardization among facilities maintains the status quo of artificially expensive launch services.

The primary purpose for the launch site operators implementing such an operations plan is to move the site toward development of a fixed, composite launch cost for a complete and comprehensive package of services responding to the commercial customers total launch requirement. This package would include a menu of priced services, including priced options, based on the level of services which the user will require. The package should also provide an itemized baseline listing of the services and costs reflecting the minimum requirements of the launch site. This menu driven launch cost structure will allow the launching organization the flexibility to tailor their launch site requirements to those the program can afford. This cost structure will also provide the management information for the launch site to closely and efficiently monitor all launch costs.

In conclusion, a singular focus on the launch customer, enlightened and optimized maintenance practices and increased work force efficiencies, will provide an environment which will proactively ensure reduced launch site costs and increased availability of access to space to all commercial space customers.