NOV 29 1984

MEMORANDUM TO DAN TAFT

SUBJECT: International Launch Competitiveness Study

Per your request we have reviewed the letter from Peggy Finarelli regarding suggestions for the International Launch Competitiveness Study.

Point by point comment to the letter is inappropriate and not provided since we disagree with the majority of substance presented and certainly the suggested approach. The points raised by Ms. Finarelli were discussed by the working group as early as August 1984 and resolved to the satisfaction of a majority of the working group. This consensus is reflected in the working group draft of October 2, 1984.

We believe it is clearly unproductive to continue to debate minority positions when the working group has reached a consensus as to the scope and approach of the study. Attempting to accomodate the minority opinions with anything more than appropriate footnotes in the text, produces a document not supported by the majority of the principals and will fail to provide the alternatives necessary in the decision-making process.

Kaelyn Daube
Kaelyn Daube, DOT

Tom Maulsby
Tom Maulsby, DOD

George Ojalehto
George Ojalehto, DOS

STAT

EXECUTIVE OFFICE OF THE PRESIDENT
OFFICE OF MANAGEMENT AND BUDGET
WASHINGTON, D.C. 20503

NOV 26 1984

NOTE TO: WORKING GROUP ON INTERNATIONAL LAUNCH COMPETITIVENESS STUDY

FROM: DAN TAFT

Attached for your review and comment is a letter from Peggy Finarelli providing suggestions for the International Launch Competitiveness Study. I would appreciate receiving any comments on this letter by COB November 29.

Attachment

Distribution

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National Aeronautics and
Space Administration

Washington, D.C.
20546

Reply to Attn of:

November 23, 1984

LID

Mr. Dan Taft
NSIA/SSD
Room 10007
New Executive Office Building
Office of Management and Budget
Washington DC 20503

Dear Dan:

As you go off to prepare a new draft of the study on the ability of the U.S. private sector and the STS to maintain international competitiveness in the provision of launch services, we have some thoughts we would like you to consider.

First, a parametric analysis of a number of variables is clearly warranted and appears to be the approach desired by the Working Group. There appears to be consensus, and we agree, that the variables considered should include the worldwide supply of launch services, the worldwide demand for launch services, and a range of possible prices for ELVs, the Shuttle and Ariane. We feel most strongly that, with respect to any of these variables, any value desired by any agency must be included in the parametric analysis. Each agency has to provide for its principals the data he will need for the next step in our process (i.e., the SIG(Space) review of post-1988 Shuttle pricing). Thus, if we are to prepare a resource document useful for each of our principals, we must consider all cases requested. The ranges of variables NASA wants to see analyzed are discussed in enclosed papers.

Second, as regards ELVs, we believe it is intuitively obvious that the viability of an ELV company is a function of its ability to operate on a "production line" basis. We believe ELV viability can be viewed as a spectrum. At one end, we have a viable "production line" company; the demand for launch services is stable and predictable enough that the company regularly produces and launches a minimum of 4-8 vehicles per year; and the company's costs per flight are low enough to compete profitably with Shuttle and Ariane even at the current prices of these two. At the other end of the spectrum, we do not have a viable ELV company; there is an oversupply of launch services relative to an uncertain demand so the company cannot

produce and launch at a sustained rate of 4-8 vehicles per year; and the company's costs per flight are so high that--without substantial USG subsidies--it cannot compete with Shuttle and Ariane regardless of the prices that these two charge. Where in this spectrum viability crosses into non-viability is a decision that must be made by the ELV companies themselves and cannot be made by the Working Group.

Third, in looking at the market available to U.S. ELV companies, because the existing U.S. ELVs under consideration in this study have such different capabilities, we must avoid aggregation. The industry is comprised of a small number of individual companies. For an individual company to be viable, the particular demands for its particular capabilities must be such that the conditions described in the above paragraph are met. In other words, the "ELV industry" is an artificial construct. We need to look at the viability of the individual companies in the context of their individual capabilities and the specific demands for those capabilities.

Fourth, as regards the Shuttle, we believe that a balanced study should make clear to our principals that selling Shuttle flights to foreign and commercial customers is consistent with and supportive of all Presidential policies extant. In fact, that is the premise of both this study and the President's charge to NASA to develop a full cost recovery price for Shuttle operations. U.S. private sector upper stage manufacturers represent an existing healthy industry and every reimbursable Shuttle satellite launch puts millions of dollars into their pockets and into this country's economy. Furthermore, under the full cost recovery pricing policy which will apply to the Shuttle after 1988, a portion of Shuttle fixed operating costs will be covered by the customer thus further decreasing the government's cost of maintaining the Shuttle program.

Fifth, for purposes of balance, in reference to NASA's 24 flights per year flight rate, we can live with a formulation along the following lines:

> NASA projects a flight rate of 24 flights per year beginning in 1989. This flight rate can be achieved with NASA's currently funded facility and Orbiter investment. These flights include manifest projections made by NASA and DOD for USG flights. Historically, DOD projects of flight needs have been overstated. However, NASA and DOD have concluded that NASA's maintaining a flight rate of 24 flights per year is an essential part of achieving an operational and cost-effective STS. As mandated in the National Space Policy, NASA holds the development of an operational and cost-effective STS as its highest priority.

Sixth, the Working Group has expressed its interest in commenting on a fifth Shuttle Orbiter in its analysis. As I

noted at last week's Working Group meeting, continued Orbiter production is an issue with impacts reaching far beyond the international competitiveness of various launch services. Any analysis relating to a fifth Orbiter must therefore make clear that the issue is not being considered in the broad context necessary for any decision. And certainly, the frame of reference of this study is too narrow to permit any overall conclusion on continued Orbiter production, as the present draft purports to do.

Beyond the above points and the written submissions I have already passed to you at Working Group meetings, there are a number of additional points which we think need to be made in the Working Group study. We present these in the enclosed papers.

Best regards.

Sincerely,

Margaret G. Finarelli, Chief
International Planning and Programs
International Affairs Division

Enclosures

SHUTTLE PRICING

NASA agrees with the Working Group that a parametric analysis of a range of Shuttle prices is appropriate.

The prices which NASA wants to see analyzed in the study are $87 million, $83.3 million, $80 million, $75 million, and $70 million.

U.S. COMMERCIAL ELV CAPACITY

NASA proposes the following changes to the section on U.S. Commercial ELV Capacity which is on page 28 of the current draft.

U.S. Commercial ELV Capacity -- A range of values for this parameter has been considered. The low end of the range represents nominal, near-term production rates for each potential commercial launch vehicle. These numbers are based on production capacity as provided by the individual companies. The high end of the range represents maximum possible production rates if current facilities are used. These numbers are based on U.S.G. experience operating these systems.

TABLE III

	1987-1994
Delta	8-18 per year
Atlas	8-12 per year
Titan	4- 8 per year
Total ELVs	20-38 per year

U.S. STS CAPACITY

NASA proposes that the following changes to the section on U.S. STS Capacity which is on page 27 of the current draft:

U.S. STS Capacity -- The nominal baseline assumption of STS flight rates for this study is the NASA FY 1986 budget submission to OMB through 1991. NASA projects a steady state flight rate of 24 flights per year to be achieved in 1989. The outyear projections reflect use patterns consistent with those in the preceding years. These projections do not reflect changes in use patterns which may or may not occur because of the Space Station program; it is far too early to quantify such projections with any validity.

TABLE I

	85	86	87	88	89	90	91	92-94
U.S. Government								
NASA	3.8	6.7	7.8	6.1	7.2	9.3	8.3	9
DOD	2.0	2.3	5.7	8.0	10.3	8.3	9.0	9
Available for foreign and commercial	5.2	4.0	3.5	4.9	6.5	6.4	6.7	6
Budgeted STS*	11.0	13.0	17.0	19.0	24.0	24.0	24.0	24

*NASA has established 24 flights per year after 1989 as a planning baseline for budgetary purposes. The currently funded facility and Orbiter investment and continued improvement in launch processing timelines could support launch rate capability estimates up to 28 flights per year.

Benefit to the U.S. Treasury of Shuttle Usage by Foreign and Commerical Customers

The NASA appropriation request for support of Shuttle Operations is affected by the amount of reimbursable revenue generated by non-NASA users of the STS. Foreign and commercial usage of the STS reduces the amount of tax revenue required to carry out Shuttle flights. The difference over the marginal costs of providing a flight provides a return to the U.S. Treasury for each STS flight flown by non-U.S.G. communications spacecraft. This difference amounts to $54 million at the $87 million full cost recovery price proposed by NASA for 1989-91. Increasing the Shuttle's dedicated flight price above this price will without question decrease the revenue return to the U.S. Treasury if that price level causes potential customers to select an alternative launch vehicle. The marginal costs of adding a flight are relatively constant in an environment where the Shuttle is used by NASA and the DOD to meet the majority of launch requirements.

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Ariane - Without Shuttle In Commercial Launch Market

Ariane Launch Capacity

In April 1984, Ariane projected a 1985 flight rate of eight launches, and they have indicated that higher rates are possible if justified by market demand. Hence, with completion of their second launch pad in early 1986, Ariane has said they have a launch capability of at least 16 a year. With resonable additional investment, they could undoubtedly push their capability to 20 or more launches each year if the demand for launch services could support more. The Ariane-4 launch vehicle will also be available in 1986--a launch system with a lift capability equivalent to one-half the Shuttle. Thus, there is very little doubt that after 1986 Ariane could launch the equivalent of at least ten Shuttles worth of payloads each year.

Launch Service Demand (Excluding NASA, DOD, and other payloads noted)

There are many different demand projections from which to choose. Most, if not all, have historically overstated the demand for launch services in the last decade, including those made by Battelle's Columbus Laboratories (BCL) which are used in this paper.

Each year BCL makes a high and a low model demand projection of payloads expressed in terms of equivalent Shuttle flights. In the process of translating payloads into equivalent Shuttles, BCL assumes a 75 percent

Shuttle load factor. In other words, the demand, when expressed in equivalent Shuttle, is overstated by perhaps as much as one third.

Excluding all NASA, DOD. Soviet-block countries (except China), materials processing, science development, and Spacelab payloads, BCL's high model projections through 1991 never exceed eleven (11) equivalent Shuttle flights per year; and, the low model projections approach seven (7) equivalent Shuttle flights.

To summarize these demand projections, it is unlikely that a demand of eleven full equivalent Shuttle flights will be realized by (1991). Since the projections are overstated by as much as one third (75 percent load factor) and the fact that even the BCL low model has historically been high, a demand as high as seven full equivalent Shuttle flights in any single year through 1991 may not be realized.

Conclusions and Summary Comments

Given the above description of the Ariane launch capabilities and demand projections, several conclusions and summary comments can be made:

(1) From 1987 through at least 1991, Ariane's launch rate capability exceeds the free world's likely payload demand for launch services.

(2) Increasing Shuttle's recommended launch price, as TCI and others have suggested, will not alter conclusion (1) above.

(3) On the other hand, raising the Shuttle price will almost certainly be detrimental, if not disastrous, for those private commercial operations that provide upper stages and facilities for the Shuttle Program. These privately financed activities represent investments totaling several hundred million dollars. Most, if not all, of this would be lost if Shuttle were to lose its commercial business through increased launch prices.

(4) If the Shuttle were not in the commercial launch market because of its high price, would Ariane capture all of the market?

From a capacity point of view, Ariane could capture all of the market. In the first few years after 1988, that would most likely be the case (for reasons dicsussed below). How long Ariane would maintain a market monopoly position would depend on a number of factors, many of which are controlled by Ariane.

If, for example, Ariane's strategy were to eliminate the threat of competition from U.S. commercial ELV's, they would have a reasonable chance of achieving that goal through price bidding designed to do just that. If and how long they might maintain such a posture no one knows. But, Ariane would clearly have that option.

(5) If U.S. commercial ELV's were only in competition with Ariane, would the U.S. ELV's be able to capture some of the launch market?

The record to date suggest that U.S. ELV's may not be able to capture any of the market. Some have explained or blamed this

situation on low Shuttle prices. This view, however, is not supported by the facts. So far (with one possible exception--the GD/Rainbow case) U.S. commercial ELV's, while under pricing both Ariane and Shuttle in a number of specific bidding situations, have not been able to secure customers. In part, this reflects the fact that price is not the only issue of concern to customers. While price is an extremely important factor, customers are also placing high priority on reliable and credible service (along with other factors). The U.S. commercial ELV organizations have yet to establish themselves in this arena. Removing Shuttle from the competition through higher prices will not solve this problem for the U.S. ELV's.

(6) Even though customers of launch services want the benefits of competition, it would take some time for a new commercial launch servicing organization (even of an existing ELV) to gain the confidence of those in the market place. This consideration further supports the conclusion that Ariane would have a monopoly position for several years if Shuttle were not in the market.

(7) Given the high national prestige associated with space, other foreign governments (e.g., Japan and China) would have a strong incentive to accelerate their plans to provide launch services if Shuttle were not in the market place. While there are serious questions about U.S. commercial ELV's being able to compete with just Ariane, that they could do so against other governments as well raises even a more serious question.

(8) NASA's budget and U.S. tax payers cost for the Shuttle program would increase if Shuttle is removed from the commercial market. In the 1989 through 1991 period five commercial Shuttle flights each year are shown in NASA's FY 1986 budget. At the recommended $87M price per dedicated flight, approximately $50M of that covers costs that NASA incurs whether or not that flight takes place. Therefore, if Shuttle does not fly five commercial flights, NASA's budget and U.S. tax payers costs for the Shuttle are increased by $250M (1982 $) each year--<u>one billion</u> dollars over four years.

(9) Since nearly all commercial payloads that fly on Shuttle require a U.S. commercially provided upper stage, this U.S. commercial space industry would be heavily impacted, if not destroyed, if Shuttle were not in the commercial market. Five Shuttle flights of commercial payloads, represent approximately $200M in U.S. commercial upper stage business.

EXPENDABLE LAUNCH VEHICLES

The future (1988 -) launch requirements of the non-European competitive commercial communications satellite market, in our opinion, is probably on the order of 10 to 12 missions per year--i.e. 4 to 8 STS missions per year--depending on future satellite sizes. This estimate is predicated on the assumption that by 1988 the equator could be essentially saturated with communications satellites--electromagnetically not physically, i.e., the uplink/downlink beams of the satellites would overlap each other such that additional units will increase the interference from such overlap to intolerable levels. Such a situation would lead to a steady-state traffic in primarily replacement units only--which means a launch rate that reflects essentially the launch rate of the units being replaced--most of them launched 7 or 8 years earlier--at a rate of 10 to 12 per year or less. Further, we assume that any mission that opts for PAM-DII is one less mission on PAM-D--or perhaps even one less mission on Atlas/Centaur--i.e., PAM-DII will be a different, improved capability servicing essentially the same market, not adding to the market. This assumption recognizes the reality that the subject launch requirements are generated by paying customers on the ground, not available launch support in space.

The first question in assessing the future ELV market--how many of these future communications missions are truly potential Delta/PAM-D, or Delta/PAM-DII, Atlas Centaur missions requiring vehicle performance within the range of these vehicles. Current projections (see the current Shuttle Manifest) are that 75% of future "Delta-class" missions will require PAM-DII capability. This consideration could be critical to the future of a commercial Delta Program since PAM-DII is targeted at spacecraft weighing 3,000 to 4,200 pounds. This is beyond the current capability of Delta 3920 which is limited to spacecraft weighing 2,850 pounds. Even the simple completion of integration of the Castor-IVA capability (higher performance solid fuel in the nine booster strap-ons) by a commercial operator will increase that performance to only 3,100 pounds.

Another key consideration is that some, if not most, of future communication satellites should be expected to grow in diameter as well as weight to maximize efficient, cost effective utilization of Shuttle unique capability as well as maximize use of the shrinking number of sychronous equatorial locations discussed above (uplink/downlink beam limitations).

If some satellites being designed now (which will be ready for launch starting in 1988) are designed to take maximum advantage of Shuttle (referred to as the "tuna-can" shape) rather than retaining earlier designs that took maximum advantage of ELV's (referred to as the "lipstick" shape) they will soon grow beyond Delta's 8-foot diameter--and eventually even Atlas/Centaur's 10-foot diameter. It should be noted that Atlas/Centaur currently has the capability to insert satellites weighing up to 5,200 pounds into transfer orbit and potentially up to 5,600 pounds. Since this vehicle needs no perigee stage each gain by the Atlas/Centaur commercial operator is a loss by the commercial producer of PAM--McDonnell Douglas. This concept of launching two "Delta PAM-DII class" satellites on an Atlas/Centaur as the Ariane-3 does is obviously not feasible since two satellites would weigh 6,000 to 8,000 pounds and the mounting adapter (what Ariane calls "SYLDA") is several hundred pounds more--much beyond the vehicle's performance. The Atlas/Centaur prime contractor, General Dynamics/Convair (GD/C) is also the selected commercial operator of the Atlas/Centaur vehicle and we understand that options being considered by them include Atlas boosters with a variety of upper stages (including the Delta second stage) that would efficiently launch a wide range of payload weights including those being designed for PAM-DII launch on Shuttle weighing 3,000 to 4,200 pounds. GD/C is considering both dual and single launch capabilities.

With Ariane offering launches of "Delta-class" missions for $25M to $35M and "Centaur-class" missions for $45M to $65M, commercial, U.S. ELV's will have to compete by offering prices at least equal to and probably below (as an added inducement) Ariane prices. Considering the sensitivity of launch costs to flight rate, we believe such competition for any extended period of time by U.S. ELV's is contingent upon establishing a business base of 6-8 launches per year; this will be very difficult without some form of U.S. Government subsidization being assigned to these launchers.

COMPETITIVE COMMERCIAL SATELLITE MARKET

Delta

The information contained in Table IV, page 29, regarding PAM-D/PAM-DII projected market is approximately 20% higher than is envisioned by NASA for the combination of those payload-assist-modules in satisfying demands of users, including the U.S. Government. Additionally, the table's projections on the mix of PAM-D's vs PAM-DII's indicates a higher demand for PAM-D's (48) than PAM-DII's (31) in the 1988 to 1994 time frame. This is contrary to the projections of the manufacturer (MDAC) of the PAM-D/PAM-DII payload assist modules since MDAC anticipates that the demand for PAM-DII class spacecraft launchings could be several times that of PAM-D class spacecraft launchings in the same time frame. Also, a quick review of the August 1984 Space Shuttle payload flight assignment for missions planned in the 1988-1994 time frame would verify this assessment. In reviewing Table-IV, it may be construed that PAM-DII class satellites can be targeted for launch both on a commercial Delta or Atlas/Centaur vehicles. With respect to the Delta vehicle, the current version of the highest performing Delta 3920 vehicle does not have the performance capability or design characteristics to launch PAM-DII class satellites for several reasons:

- The PAM-DII was not designed for launch of payloads on Delta. A new configured version would have to be developed at a significant investment as the current PAM-DII is not adaptable to Delta or does not meet its interface requirements. The size of the current PAM-DII restricts its fit within the standard Delta spintable and attach fitting and the weight (assuming appropriate interface) would severely degrade the performance of the Delta vehicle for missions requiring geosynchronous transfer orbit--a massive trade-off in spacecraft weight would have to occur which would render the Delta ELV noncompetitive in terms of cost and payload performance.

- The standard Delta fairing is approximately an 8' diameter fairing. The diameter of most, if not all, PAM-DII class payloads is expected to exceed that and would proabably require new fairing designed in the 9' to 10' diameter range. It is estimated that such a fairing would require a minimum investment of $7.0M to $10.0M investment (nonrecurring). Assuming that such a new fairing is developed, it would certainly change the flight dynamics of the Delta vehicle, the additional weight and size would cause more performance drag, and would require even more vehicle performance to offset expected losses or degredation in spacecraft weight because of the heavier and wider fairing. It would probably be impractical to develop such a fairing for use on Delta for PAM-DII class payloads without making a substantial investment in upgrading the Delta first stage engine (Rocketdyne RS-27) and/or the Delta second stage engine (Aerojet AJ-10).

- The standard Delta Castor IV motors along with the standard RS-27 first stage engine, the AJ-10 second stage engine, and the PAM-D payload assist module are capable of accomplishing launch of a 2,800 pound payload in a geosynchronous transfer orbit--a PAM-D class payload. In order to accomplish the same orbit for a larger payload up to 3,100 pounds, at the low end of the PAM-DII class, the Castor-IV motors would have to be upgraded/modified requiring an investment of $3.0M--$5.0M (nonrecurring). Additionally, once the modifications have been accomplished a recurring cost of approximately $0.7M per vehicle launch is estimated to add to the cost of launch.

Lacking major investments in a new PAM-DII type payload asssist module, new fairing(s), and upgrading of Castor-IV motors, it is highly unlikely that any of the PAM-DII payloads would be launched by the Delta vehicle. On the other hand, even if new investments are made in the development of a new size fairing and upgrade of the Castor-IV motors, only payloads of 3,100 pounds or less could be launched on a commercial Delta. Since most of the out-year payloads (1988-1994) are expected to be heavier than 3,100 pounds the only other commercial vehicle capabilities would be the Atlas/Centaur and Titan vehicles.

ATLAS CENTAUR

Table IV projects a launch requirement of (24) Atlas/Centaur class payloads for the FY88-FY94 time frame. This estimate exceeds past actual Atlas/Centaur activities (payloads in the 5,000 pound range), by at least 60-70%. On the other hand, General Dynamics/Convair (GD/C) who is the selected commercial operator has developed market projections (for payloads between 3,500 and 5,600 pounds), that are triple those in Table IV. Since Shuttle PAM-DII performance estimates reach up to 4,200 pounds for geosynchronous transfer requirements, and since GD/C's projections include payloads starting at 3,500 pounds as the Atlas/Centaur class, a major portion, if not all, of the PAM-DII projections in the table could probably fall within the Atlas/Centaur commercial market. Except for a few payloads, more than 90% of PAM-DII class payloads are anticipated to exceed 3,500 pounds to geosynchronous transfer orbit--well within the capability of the Atlas/Centaur and certainly outside/above the performance capability of standard Delta vehicles or any affordable upgrade of Delta. Although they can be launched on the Atlas/Centaur vehicle, their weight precludes launching more than one payload at a time which results in a significant underutilization of the Atlas/Centaur capability. Therefore, by today's standards and cost projections, single payloads in the PAM-DII class range (3,100-4,500 pounds) that could be launched on the Atlas/Centaur vehicle would probably not be competitive in price (cost of launch) when compared to Ariane which would, perhaps, be able to more fully match lift capability to payload requirements. Accordingly, customers with payloads in the PAM-DII weight category would more likely than not choose a launch source other than Atlas/Centaur. For payloads above 4,200 pounds up to the expected capability of 5,600 pounds, there would appear not to be a sustaining commercial market of any reasonable size to allow competitive launch costs. Combining, however, all payloads depicted in Table IV for PAM-DII and Atlas/Centaur categories would provide a much larger base (average 8 launches per year) to prorate costs and would probably generate competitive launch costs with Ariane's assuming Ariane's pricing is not adjusted to reduce the available Atlas/Centaur base.

An option which could be available to the GD/C would be to mix two (2) smaller payload combination at the same time as is done with Ariane. This would cut costs to users on the single flight. Although combining two PAM-DII class payloads would be in excess of the Atlas/Centaur vehicle performance capability estimated to be no more than 5,600 pounds, a potential combination could be to mix two PAM-D's classes or one PAM-D and a PAM-DII class and thus, this may prove to be feasible.

Nonetheless, for Atlas/Centaur vehicle launchings to be cost competitive with Ariane, one must assume that this vehicle would have to capture the PAM-D, PAM-DII and Atlas/Centaur class markets achieving a launch rate of at least 12 or more spacecraft per year. A constraint to overcome, however, would be to develop a launch capability which could react to such high launch demand--inconsistent with past Atlas/Centaur practices.

Titan-III Launch Capacity

The Titan family of launch vehicles was developed for USAF requirements to launch heavy payloads into low Earth orbit. NASA utilized the highly capable Titan-IIIE/Centaur to launch several planetary payloads in the 1970's. In order to provide assured launch capability to compliment the Shuttle, the USAF is considering development of a Titan 34-D/Centaur configuration to launch geosynchrorous payloads of about 10,000 pounds. In addition, modification of the Titan-II ICBM's is being considered for west coast launches of Defense Meteorological Satellites in the 1990's. Currently there are 56 Titan-II's which could be used. The Titan-II represents the core stage of the Titan-IIIC without the strap-on boost phase solids the Titan-IIIC uses for additional lift capability. The non-recurring costs of modifying the existing Titan-II ICBM's and Vandenberg launch pad is estimated as about ___ million, with modification and launch support costs on the order of ___ million per launch. (The prospective availability and non-recurring costs of the Titan-II ICBM's for east coast commercial launches are unknown since there is no existing Titan-II capability at ETR and the Titan-III complex would have to be modified to accommodate the Titan-II version).

The east coast launch capability of the Titan/Centaur is projected to be about 3-4 launches per year. This launch rate is constrained by the capacity of the vehicle assembly building. Expansion of the 3-4 launches per year is conceivable, but the investment costs required are probably considerable, i.e., in excess of ___ million. Assuming that the USAF selects the Titan/Centaur alternative for providing assured launch capability, two launches per year would be utilized by the USAF for national security payloads. Availability of the residual capacity for launch of heavy commercial payloads is conceivable, with the major consideration being price competitiveness with the Ariane. Additional development would be required to provide a multiple payload capability that would enforce the competitiveness of the Titan for conclusive PAM-DII class payloads.

The price for Titan-III commercial launches is probably in the ___ million range.