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AIRCRAFT WEIGHT PREDICTION CAPABILITY

VOLUME 1: WEIGHT STUDY AND RESULTS

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FINAL REPORT FOR 01/01/92-05/30/93

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This technical report has been reviewed and is approved for publication.

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13. ABSTRACT *(Maximum 200 words)*

This report presents the study results, conclusions and recommendations of the application of various weight prediction methodologies to three modern aircraft that are representative of low observable (LO) and/or advanced technologies. In the continuous effort of the Mass Properties Group of the Flight Systems Engineering Division to improve the correlation of predicted weight to actual weight, this report and the corresponding study are intended to serve as a guide to the strengths and weaknesses of current available prediction methodologies, identification of technical areas for which methodology is either lacking or inadequate and recommendations to enhance our capability.

Volume 1 of this report documents the background of the study, the weight estimation process of this office, the approach to the study, general results, conclusions, and recommendations to correct deficiencies and improve the Air Force capability. The following volumes will document the methodologies used and the detailed results for the aircraft analyzed.

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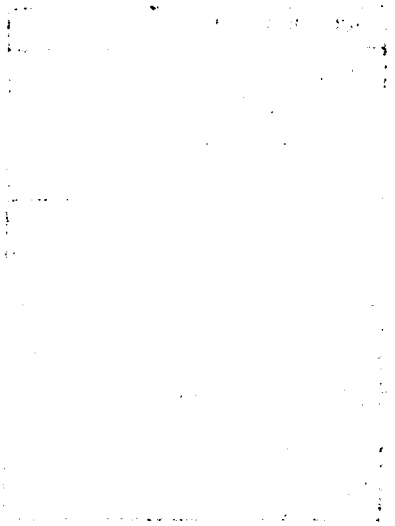

FOREWORD

This report was prepared under the authority and responsibility of the Flight Systems Engineering Division, Integrated Engineering and Technical Management Directorate, Aeronautical Systems Center (ASC/ENFS), Wright-Patterson Air Force Base, Ohio. The work was requested in a 30 January 1992 memo from ASC/EN at the request of Headquarters, Air Force Materiel Command, Engineering (AFMC/EN), who was responding to General Franklin (AFPEO/TA), the Program Executive Officer (PEO) for tactical systems. The technical analysis was completed in September 1992 with briefings to the appropriate Program Offices, ASC/ENF, ASC/EN, HQ AFMC/EN, and finally to General Franklin.

Volume 1 of this report is unclassified, contains no proprietary information and has unrestricted distribution. However, the subsequent volumes are, by their very nature, proprietary and in some cases classified.

The study team consisted of Thomas E. Oole, ASC/SDEJ (lead engineer), Robert Anderson currently retired from WL/XPAD, Irv Schaff (ASC/YSDF), Lt Andy Batten (ASC/SDEF), Wayne Raney (ASC/ENFSL), and Lt Bruce Wilder (ASC/ENFSL).

PREFACE AND ACKNOWLEDGMENTS

The team would like to thank those who have indirectly helped us by providing the contractor methods that made it possible for the Air Force to estimate air vehicle mass properties. Those company methods that were used in this study were from General Dynamics, Fort Worth, Texas; The Boeing Company, Seattle, Washington; Northrop Corporation, Pico Rivera, California; McDonnell Aircraft Company, St. Louis, Missouri; Martin Marietta Corporation, WPAFB, Ohio; and Vought Corporation, Dallas, Texas. Many other methods were evaluated, but for various reasons were not used in this effort. The team would also like to express its appreciation to the companies that produced the aircraft in the study for their actual weight reports. Those three companies are Northrop Corporation, Lockheed Corporation, and the Douglas Corporation. The team would also like to gratefully acknowledge the current and past efforts of weight engineers both in and out of the Air Force for without whom weight estimation would not have reached the level that it presently occupies.

LIST OF SYMBOLS, ABBREVIATIONS, AND ACRONYMS

AFMC/EN - Integrated Engineering and Technical Management, Air Force Materiel Command
ASC/EN - Integrated Engineering and Technical Management, Aeronautical Systems Center
ASC/ENF - Flight Systems Engineering, Integrated Engineering and Technical Management Directorate, Aeronautical Systems Center
ASC/ENFS - Structures Division, Flight System Engineering, Integrated Engineering and Technical Management Directorate, Aeronautical Systems Center
ASC/ENFSL - Loads Section, Structures Division, Flight System Engineering, Integrated Engineering and Technical Management, Aeronautical Systems Center
ASC/SDEF - Flight Systems Engineering Branch, Engineering and Technical Management Division, Aircraft System Program Office
ASC/SDEJ - Joint STARS Branch, Engineering and Technical Management Division, Aircraft System Program Office
ASC/YSDF - Flight Systems Engineering Branch, Engineering and Technical Management Division, B-2 Systems Program Office
ECP - Engineering Change Proposal
DOD - Department of Defense
LO - Low Observables
PEO - Program Executive Officer
psi - pounds per square inch
RAM - Radar Absorbing Material
RAS - Radar Absorbing Structure
USAF - United States Air Force
WL/XPAD - Advanced Design Division, Plans and Program Directorate, Wright Laboratory
WPAFB - Wright Patterson Air Force Base
2-d - Two dimensional

1.0 SUMMARY

This study unequivocally showed that given a fixed or frozen design with adequate data (as should be the case at source selection), USAF Mass Properties engineers could predict the structural weight (per MIL-STD-1374 definition - wing, tail, body, gear and air induction/engine section) of an aircraft of any configuration regardless of LO or advanced technology to within 3% of its actual value. This is significant since structural weight comprises between 57 to 68 percent of the aircraft weight empty. It also showed that the propulsion weight (per MIL-STD-1374 definition - engine, gear box, exhaust, controls, starting, lubrication, fuel system, etc.) prediction methods available were inadequate and are highly dependent upon an accurate engine weight. Likewise, the equipment weight (per MIL-STD-1374 definition - flight controls, auxiliary power plant, instruments, hydraulics, electrical, avionics, armament, furnishings, air conditioning, etc.) methods were lacking in precision and lagging behind current technology. The low observable weight was found to be a small percentage of the weight empty and it is recommended that our future effort should go into improving propulsion and equipment prediction methodologies. It should be stressed, however, that the continuous improvement and upgrading of all aspects of our mass properties predictions (methodologies, manpower, training, data, etc.) must still continue in parallel.

2.0 INTRODUCTION

This report provides the background of the study, familiarizes the reader with the weight prediction process, informs the reader on the study approach, presents the overall results of the study and makes recommendations for the future.

3.0 BACKGROUND

On 30 January 1992 Mr. John Griffin, then ASC/EN, sent a memo to Mr. Howard Wood, ASC/ENF, to initiate a study to assess the current ASC/EN weight prediction methods with emphasis on low observable (LO) and advanced materials technologies (Appendix A includes the memo). The study was to identify, document, and where feasible, correct deficiencies and limitations of the methodologies. After the study was completed the team was to develop, document and report recommendations back through ENF, EN, AFMC/EN and finally to the PEO.

This tasking was largely the result of a conversation with Maj Gen Charles E. Franklin, Program Executive Officer (PEO) for Tactical and Airlift Programs; Mr. P. Panzarella, AFMC/EN; and Mr. Griffin. It reflects the General's concern over weight prediction capability in the Air Force.

By 4 March 1992 a Charter (Appendix B) was approved by all the affected program offices and a team was formulated. The team consisted of Thomas E. Oole (ASC/SDEJ), the leader of the group; Robert Anderson (WL/XPAD), later ASC/XRH and now retired, methodology expert; Irv Schaff (ASC/YSDF) chief evaluator, Lt Andy Batten, technical assistant, and Wayne Raney (ASC/ENFSL), secretariat. Dan Sheets (ASC/SDEF) was a facilitator for the F-117 and Lt Bruce J. Wilder (ASC/ENFSL) provided graphical assistance. Initially, the F-117, B-2 and F-22 were chosen as study subjects due to their LO characteristics and advanced systems and materials.

By 1 May the team members' security clearances were verified, access into the B-2 program office was granted, and the evaluation was begun. By 10 August the team had basically completed the initial B-2 analysis and was cleared into the F-117 office for its evaluation. A scheduled status briefing was given to Mr. Panzarella on 10 September 1992. At this time a decision to drop the F-22 from the study and add the C-17 weight evaluation (completed in 1985 in support of the post award process) was made because there was no actual weight on the F-22 at this time to compare to a predicted value and because the study was already taking more time than was previously considered. Mr. Panzarella received a briefing on results/conclusions at the completion of the analysis on 18 December 1992. Maj Gen Charles Franklin was given the final briefing on 25 January 1992.

A more detailed description of the effort is in the team minutes which may be found in Appendix C.

4.0 WEIGHT PROCESS FAMILIARIZATION

In the aircraft developmental process, weight prediction usually progresses in a very distinctive way (Figure 1). During the early design phase of an aircraft (conceptual design or Phase 0 of the Acquisition Life Cycle), relatively simple statistical predictions are used to predict the weight of an aircraft. These methods normally employ one simple equation for each weight group called out in MIL-STD-1374 (Wing, Tail, Fuselage, Gear, etc.). At this phase these equations normally are adequate in that they provide the fidelity and accuracy necessary. Further, the design traditionally lacks hard and detailed data which precludes the use of more detailed and complex methods. For the next step of the acquisition process (Source Selection) a higher level of prediction method is used. We can refer to those methods as Parametric Estimation Prediction techniques. This is the level of estimating that was done for this study and normally would be the level used on a new developmental aircraft at source selection. The process described in the report may be used anytime the extensive input data required is available, but generally should only be used at this time. At Phase 0 it is too costly to do this analysis with the magnitude of changes in the design, and after the awarding of the contract the weight estimation effort usually turns into a weight control and optimization effort. After contract award, the contractor usually divides the estimated weight into individual pieces, assemblies or manufacturing drawings. This is referred to as "allocation of weight." This allocation provides a "yardstick" or "target" by which the effectiveness of weight control/optimization may be assessed as the design matures. Throughout development the contractor continuously refines these values by estimating part weight from layout, unreleased drawings, and vendor inputs. The next level of weight accuracy improvement is reached with weight calculations based on signed and released drawings. This constitutes something of a milestone as not only are considerable design details now available, but also it can reasonably be expected that the system will not change to any great extent. During the final stages of development, parts that have been produced are actually weighed on a highly accurate calibrated scale. This is the last and highest level of part weight accuracy. When the aircraft is fully assembled it is actually put on a scale and weighed as a whole. This weight is what the specification performance normally is based on.

As indicated above, this study focused upon the application of the Parametric Estimation technique with an occasional reference relative to other techniques used at other times in development. Parametric Estimation Prediction is far more complicated than the single equation per weight group as experienced in the simple statistical prediction methods. There are typically multiple equations per weight group each with multiple and detailed data parameter inputs. As an example, one method in the ASC/ENFS library has over 20 equations to predict a basic fuselage. This method uses separate equations to calculate weight increments for the basic shell, the bending moment contributions, cockpit provisions, nose and main landing gear provisions, wing reactions, fuel provisions, air induction provisions. engine provisions, vertical and horizontal tail provisions, canard provisions, arresting gear provisions, speed brake supports, store provisions, gun provisions, windshield and canopy provisions, radome provisions, catapulting provisions, etc.

Weight Progression

Simple Statistical Prediction

Parametric Estimation Prediction (Study Level)

Contract Award

Allocation of Weight

Refinements (layout, vendors weights)

Calculations of Released Drwgs

Actual Weight Parts

Actual Aircraft Weights

FIGURE 1 WEIGHT PROGRESSION

The equations of the parametric method are developed from historical data. It has been the experience of the weight community as a whole that the past can predict the future. With a sufficiently large and comprehensive data base, the predecessors of many a modern configuration and systems can be found and are factored into the creation of parametric prediction equations. It is important to realize that the majority of weight prediction methods are statistical and thus, by definition, not as absolute as other engineering discipline formulas. Another fundamental truth of weight prediction is that our estimating techniques can only estimate for a defined configuration, not a future configuration that has not yet been considered. Also, if the fidelity of the configuration is poor, the weight estimation can be no better. Therefore, it can be said that weight prediction is a complex process and not a pure science.

The approach to weight prediction in ASC/ENFS is quite unique and this approach is not used in industry or, to our knowledge, anywhere else. We do it this way because we have the unique capability of access to multiple proprietary methods. If industry had this access they too would estimate weights in this manner. Only with this access can we do predictions in the manner that we do. Figure 2 gives an overview of how ASC/ENFS has successfully been predicting weights for many years.

First, one must analyze the task at hand. Is the aircraft to be analyzed in the conceptual phase where all that is frequently available is a simple three view drawing. Is it an off-the-shelf aircraft that is being modified for a new mission or a civilian certified aircraft being militarized? Perhaps it's a new aircraft being proposed and a source selection is underway. What are the aircraft user requirements? What kind of an aircraft is required? What is the aircrafts mission profile? What payload is it carrying and how far is it carrying it? What is the proposed crew size? Is there any special equipment for its mission? What about its usage and desired life? One must understand the amount, detail, and limitations of the data available. Is the data for the effort vague and limited or is it a well defined proposal? What type of time constraints are there? Do you need the answer that day or will it be acceptable in 3 weeks? The answers to the above questions must be understood by the person doing the estimate before going on to the next step.

The second step proceeds in parallel with the third step (see Figure 2). This is to start gathering the data necessary to start the weight prediction. This data may be as simple as gathering and tabulating the equipment weights for a modification, or it may be as time consuming and complex as that required to do a Parametric Estimation Prediction in which 100 or more input parameters may be and often are required. These parameters are values such as Design Gross Weights, load factors, wing span, fuselage length, flap chords, gallons of fuel in each tank, tank locations, material properties, etc.

The third step which is pursued at the same time as the second step (see Figure 2) is to go to the weight library. The library has actual weight reports on almost all past Air Force aircraft. This is the historical basis for all our weight prediction methods. This data is used in developing methods, finding weight increments for various design features, and for the final weights needed to verify that the chosen prediction methods from step 2

Weight Estimation Process
(Overview)

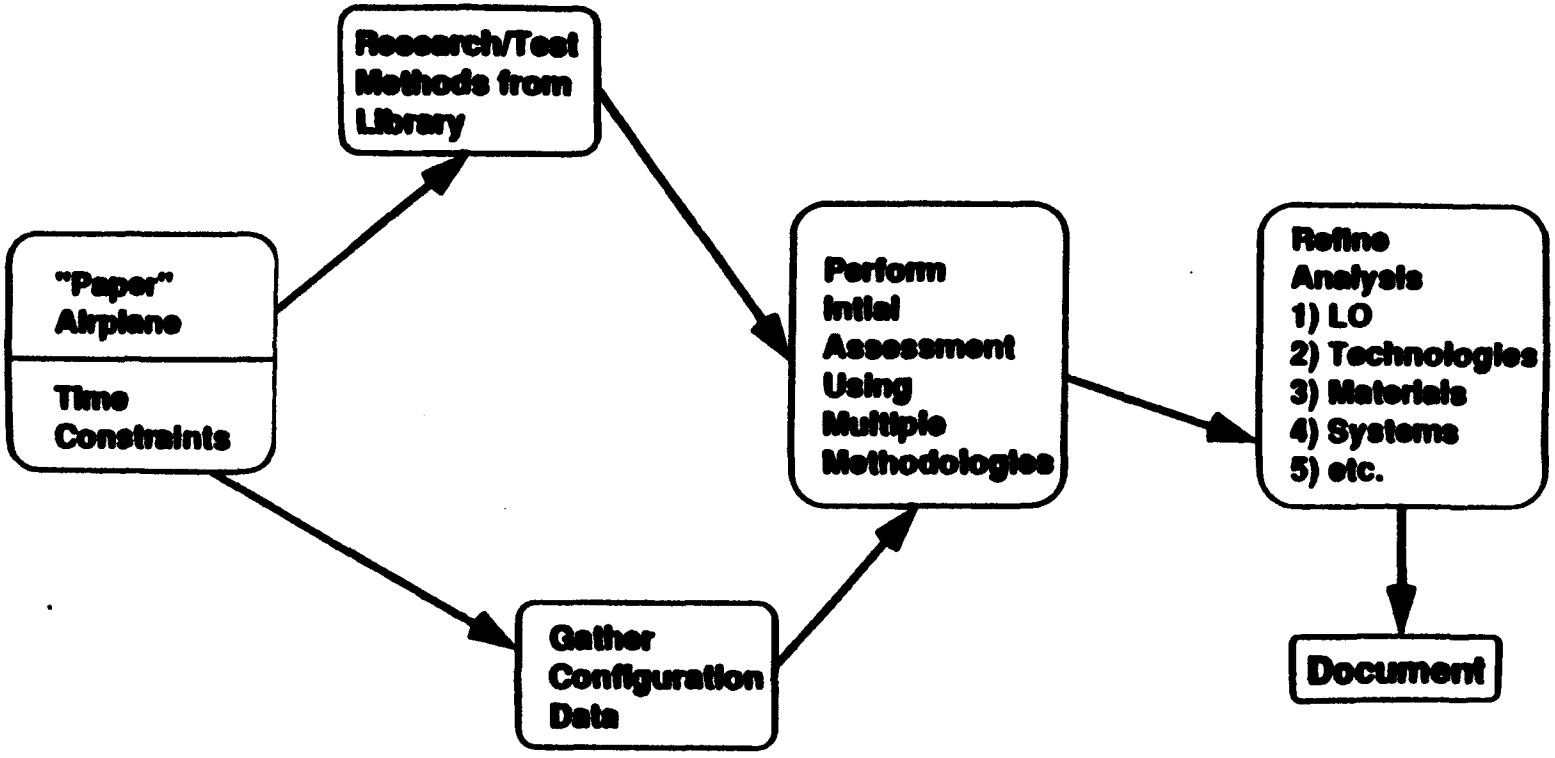

FIGURE 2 WEIGHT ESTIMATION PROCESS

accurately account for the configuration or equipment of the to-be-assessed aircraft. It has data on equipment that may be used in modifications, Reality check (rule of thumb) equations, simple statistical prediction methods (1 equation per weight group) and Parametric Estimating Prediction methods. The library also has weight prediction methodologies collected over the years. As many of these methods are contractor proprietary (developed with company funds and are not releasable outside this office without the consent of the company), much care and forethought must be exercised. Based upon past experience and the methodology narrative instructions on applicability, one must then determine which methods apply to the task at hand, and then test those methods against historical aircraft with similar characteristics to that being evaluated. For instance, the methods being employed might be tested for a B-2 against a B-49 flying wing, for an F-22 against maybe an F-16 or F-15, or for a C-17 maybe a C-141 and C-5 . Yes, there are may differences but there are similarities enough to prove the validity of the method chosen or show its limitations. It is to be noted that multiple methods will usually be chosen to be applied, and that probably a mix of methods will be used for various area or weight groups. For instance method X may be used for the wing and fuselage, method Y for the tail, and method Z for the gear.

The fourth step in the process is to perform the initial assessment using the chosen multiple methodologies. The results of this work will give a matrix as shown in Figure 3. The actual calculations are a pure "plug and grind" process using the data acquired in Step 2. After the matrix is formulated one must now choose which values in the matrix to use for each weight group. As stated in the above paragraph, method X may be used for several weight groups, method Y for other weight groups and method Z for still other weight groups or weight increments. This is where the engineering knowledge of the aircraft and methods will come into play. Weight estimators have been accused many times of just using the highest value. But this is not what the process does. Each evaluator must justify the process that is used. For instance, on the C-17, one company's fuselage results stood out to be significantly different from the other methods that were employed. After careful consideration it was determined that their method accounted for aircrafts uniquely high design sink speed where the other methods assumed a more benign normal transport sink speed. As the C-17 sink speed was a large contributor to the fuselage design, the one company's method best accounted for that feature was chosen for the fuselage weight methodology used. As it turned out, this was not a bad approach. Care must be taken when mixing various methods that there is an understanding of what the methods are estimating. For instance, one company includes the wing carry-through structure weight in the wing group and another includes it in the body. If one is to "mix and match," then these differences must be carefully taken into consideration.

Step 4 provides an initial estimate of weight for a conventional technology (metal) aircraft of the general characteristics of the aircraft being evaluated. Step 5 refines this analysis for any unique features or other differences from the initial metal aircraft estimate. Here again, one must be familiar with the methods used, including the methods data base and the requirements of the aircraft being evaluated. The analysis may need to be refined for many design features such as Low Observables (LO) techniques, advanced structural

Initial Assessment

Methods	A	B	C	D	E	F
Wing	X	O	X	X		X
Tail		O	X	X		X
Body	X	O	X	X	X	X
Gear	X	O	X	X		X
Air Induction		X	O	X		
Propulsion		O		O		
Flight Controls		O		X		
APU		O		X		
Instruments		O		X		
Hydraulics/Pneumatics	O	X		X		
Electrical	O	X		X		
Avionics		O		X	X	
Armament (N/A)						
Furnishings		X		O		
Air Conditioning		O		X		
Anti-Icing		O		X		
Photographic (N/A)						
Load and Handling		X		O		

X = Performed analysis but not used in assessment, O = Used in assessment

FIGURE 9 INITIAL ASSESSMENT

materials and new generation equipment systems. Radar Absorbing Structure (RAS) is usually treated as a material change or by an incremental factor based on the knowledge of the material and past experience. Radar Absorbing Material (RAM) is usually applied to the normal structure like paint or aerodynamic putty and in gasket materials. Therefore, it is generally estimated by the area of the surface it is being applied to plus the length of the seals. Other LO weight increments are estimated on a case-by-case basis based upon the detailed design and cannot be discussed at this unclassified level. Changes in the technologies baseline such as submerged inlets, vee tails, flying wing designs, and aircraft usage are accounted for by adjusting the equations in the methods based on similar designs found in the weight library. For some extremely advanced features such as integrated avionics and 2-d vectoring nozzles, knowledge gleaned from the Air Force Advanced Technology Development Programs, attendance at various professional conferences, individual research and multi-discipline engineering classes would be applied. Material differences from the basic aluminum aircraft are handled in many ways depending on the knowledge of the material being used and the location of that use. The "Failure Mode Analysis" as described by Steven J. Zaidel (McDonnell Aircraft Company), Society of Allied Weight Engineers Paper no. 1849 titled IMPACTS OF ADVANCED MATERIALS/STRUCTURAL CONCEPTS ON FUTURE WEIGHT ESTIMATION is one of the most rational ways to approach material differences when the areas are considerable and a lot is known of the new material and its application. It is known that different areas of the aircraft are designed by different modes. For instance, the wing is generally designed for 29% tension, 29% compression, 16% buckling, 2% crippling, 7% shear, 9% stiffness, 8% torsion (by weight). Knowing the material characteristics of the new material and of aluminum, the weight can be derived by the ratios of the material properties and the design characteristics. Construction techniques of the new material, temperature considerations and the like can also be accounted for in this method. Not much has been said about adjusting the values for advanced systems such as for 8000 psi hydraulics, variable speed generators, and load and handling requirements. These areas are adjusted using techniques found in technical papers from conferences, vendor inputs, and knowledge of past equipment requirements of the user.

An uncertainty factor (growth) must be used to compensate for minor unknown configuration changes (not ECP changes), input data inaccuracies and optimism, overly optimistic material properties, manufacturing considerations, weight management approach/control, scheduling problems, cost considerations, etc. This value is derived from historical data as there have been many studies to show that all programs, even if they were prototyped, have grown above the original estimate.

5.0 APPROACH TO THE STUDY

The approach to the study differed slightly from the above because the object of the study was to test our methods for accuracy. Therefore, Step 1 and Step 3 as described in Section 4 were modified. The team first familiarized themselves with the design and performance criteria of the aircraft to be evaluated (the B-2, F-117 and later the C-17) as normally done in the Step 1 procedures discussed above. We surveyed and organized the applicable methods that were available from the library at that time (it should be remembered that the library is continuously being expanded and updated) as required in Step 3. However, we did not test the methods against similar aircraft since our purpose in this study was to evaluate our methods against the chosen aircraft designs. As is normal in Step 2, we gathered the available actual data for the aircraft to be studied. We conducted the weight empty parametric estimations (Step 4) for the selected vehicles (B-2 and F-117) and refined the analysis to compensate for the aircraft differences from the data base as described in Step 5 above. These values were compared to the actual weight as reported in an actual weight report. We also compared the C-17 actual weight against a parametric level study which was conducted in 1985. The results were briefed to various interested parties and then documented in this technical report. Volume 2 of this technical report documents the C-17 study, Volume 3 documents the F-117 study and Volume 4 documents the B-2 study. This technical report is divided in this manner because of the proprietary nature of the methods used in this study and because of the security problems that are involved with these aircraft. The general results of the study are discussed below.

6.0 ASSESSMENT OF THE RESULT OF THE STUDY

For the B-2, the weight estimation proved to be within -2.9% of the actual weight empty (a negative sign means that the assessment is below that of the actual published value). For the structures weight the methods were within -0.2%. The weight "accounted" to or "coded" to LO (low observable) was -24.7%; Propulsion was -1.6% and Systems were -5.1%. It should be noted that the final or actual parameters of the aircraft at the time of the actual weight report were used in the assessment and compared to the actual weight as reported in that weight report. At time of source selection, the anticipated or planned parameters would be used and these are likely to be modified in the final design. Much of the error between the predicted weight of the LO and actual weight was associated with how the LO was coded or defined and not necessarily because the methods were extremely poor. This illustrates the problem of weight group accounting or coding as described briefly in the paragraph outlining the fourth step procedures. However, even though the percentage of error was great, the LO weight is a small percent of the weight empty, and did not contribute largely to the percentage of error in weight empty. The majority of the difference in weight empty is attributed to missing the system weights by -5.1%. In this study System weights are considered to consist of the following weight groups: Flight Controls, Auxiliary Power Plant (APU), Instruments, Hydraulics and Pneumatics, Electrical, Avionics, Armament, Furnishing and Equipment, Air Conditioning, Anti-icing, Photographic, Load and Handling, and Manufacturing Variation. The Propulsion Group is made up of: Engine Installation (including the engine itself), Accessory Gearbox, Exhaust System, Engine Cooling, Water Injection, Engine Controls, Starting Systems, Smoke Abatement, Lubrication, and Fuel Systems. These weight groups are defined in MIL-STD-1374, Weight and Balance Forms for Aircraft. It must be realized that even though the propulsion group weight estimation was only 1.6% lighter than the actual weight, most of the weight equations employed used the engine weight in its equation. Having access to and using the actual weight of the engine falsely makes that weight group appear better than it truly is. It should be noted that engine weight methodology for airframe contractors is not advanced, and dependent on the engine manufacturer for engine weight is common. The details of the study are found in Volume 4.

As with the B-2, the F-117 actual parameters at the time of the actual weight report were used in the assessment and the estimated weight was compared to this actual weight report. The predicted weight empty was -2.6% different from the actual reported values. The parasitic structural LO was -8.8% different from the actual reported values. The Structural difference was -0.9%, Propulsion was -0.3% and Systems was -6.0%. Again it must be realized that the Propulsion weight was based on the actual engine weight and thereby giving a false impression that the methods available do a good job of calculating propulsion weights. The overriding reason for the difference in weight empty was the System weight group (just as it was for the B-2). The results of this study are found in Volume 3.

For the C-17, a study completed by then ASD/ENFS in 1985 just after contract award was used to compare with the actual weight of aircraft number one. This 1985 study should

not be construed to reflect the weights that Douglas predicted. This weight estimate was not upgraded for newer design weights, configuration changes (except changes driven by requirement changes) or the like. Therefore, these weight percentages should not be considered as growth from contract signing, but are only indicative of ASC/ENFS's ability to predict weight from contract signing. The weight empty was -5.0%, Structure was -2.3%, Propulsion was -6.8% and Systems was -14.4%. This aircraft has no LO weights. Here the study reflected the configuration of the vehicle at contract award and therefore not the actual engine weight and final configuration were not known to the estimator. This time not only the System weight but also the Propulsion weight were the predominate reasons for the difference. This study can be found in Volume 2.

7.0 CONCLUSIONS

This study proved without a doubt that our approach in ASC/ENFS can predict USAF aircraft weight empty with reasonable accuracy when the aircraft mission, usage, and configuration are known. Unique structural configurations, as exhibited by the B-2 and F-117, can be predicted with great accuracy. Advanced structural materials weight as shown on the B-2 can be reasonably predicted by experienced weight personnel. Low Observable weight predictions capability is marginal due to subtleties in the aircraft design; emerging technology; access to current data; and lack of methods and data base. However, this should not be completely negative since LO represents a relatively small portion of the aircraft in comparison to the structure, propulsion and total system weight. Therefore, investing large sums of money and time into developing methods on an emerging technology with a small data base does not seem sensible at this time. Propulsion and Systems group weight prediction capability was also shown to be lacking. Most methods for the Propulsion group key off the engine weight. The airframe community has marginal capability for predicting the weight of an engine and relies heavily on the engine manufacturer to provide an accurate weight assessment of the engine. Engine manufacturers have not published their weight methods and many engine corporations do not profess to having methods that predict engine weight in the same sense that the airframe manufacturers have prediction techniques for the airframe. System weights cover a variety of different functional groups which present problems of configuration definitions, advanced technologies and data availability. Most of the system weight groups like avionics also key off from equipment (in the case of avionics the sum of the black box weight) similar to the propulsion weight discussed earlier. Therefore, if you do not have a good definition of the equipment, you are not able to estimate the weight with any fidelity.

The study has confirmed that prediction capability is highly dependent on completeness and consistency of the data, adequate infrastructure (manpower, library, etc.), experience of the predictor and access to the data. Weight data must be continually procured for the library in one format and with all mass properties engineers using the same coding and definitions. Conflicting values, unique definitions, undisciplined coding will not improve the fidelity of the weight prediction. With the reorganization, government weight prediction personnel and resources are declining.

8.0 RECOMMENDATIONS

The recommendations of this team are:

1) To improve the weight prediction methodology by:

a) continued and increased procurement of weight prediction methodologies from all DOD contractors to expand ASC/ENFS weight library,

b) releasing Air Force historical and current weight data to airframe contractors to facilitate development of new weight prediction techniques, and

c) specifically fund and task the aerospace community to develop new and improved propulsion and system prediction techniques;

2) To enhance the ASC/ENFS library by procurement of comprehensive and DOD formatted weight data in accordance to the military standards for all programs; and

3) To train dedicated weight prediction personnel to estimate weight and maintain the weight library in the home office.

APPENDIX A

To: ENFS

30 January 1992

MEMORANDUM FOR ASD/ENF (Mr Howard Wood)

SUBJECT: Assessment of and Proposed Improvments to Mass Properties Calculations

1. Mr John Gala asked me to provide you the attached information and discuss an approach for addressing the subject issue. At AFSC/EN's request, Mr Griffin has agreed to conduct a review of our existing Mass Properties prediction techniques, assess their performance for composites (specifically low observable materials and shapes) and propose improvements to deficiencies in our processes.

2. The attachment 1 letter provided to Mr Griffin for signature to HQ AFSC/EN prompted him to suggest that ENF should take up this issue and put together a team to study the problems and identify any improvements (attachment 2). *

3. In a discussion I had with Mr Gala, I suggested that the range of materials and processes for which mass properties calculations pose a challenge goes beyond composites. My own experience indicates that in addition to some of the advanced composites being developed, the fabrication processes that result in complex shapes (i.e. Hot Isostatic, thermal expansion and evacuation processes) represent a significant set of challenges for the mass properties engineer.

4. Your assessment of the best approach to take on this is required. As indicated in the attachment 1 letter, Mr Anderson (WL/XPAD) is available to support a review.

Tim Jennewine
Tech Ops Staff

2 Atch
1. ASD/EN Letter to HQ AFSC/EN (not signed)
2. Mr Griffin's Notes

DEPARTMENT OF THE AIR FORCE

HEADQUARTERS AERONAUTICAL SYSTEMS DIVISION (AFSC)
WRIGHT-PATTERSON AIR FORCE BASE, OHIO 45433-6503

REPLY TO ATTN OF: EN

SUBJECT: Mass Properties Candidate for IRT

TO: HQ AFSC/EN
ATTN: Mr P. Panzarella

Per our discussion, I am identifying Mr Bob Anderson of WL/XPAD, DSN 785-5288, as being the most experienced in the analytical prediction techniques of weight estimation for low observable, composite aircraft at ASD. We frequently use Mr Anderson for many of our programs. Mr Anderson has been contacted, and he is available to support a short term review.

JOHN M. GRIFFIN, SES
Chief Systems Engineer
DCS, Integrated Engineering
and Technical Management

Griffin's notes (transcribed)

Develop a technical process for weight estimates, particularly for today's high composite material content aircraft with low observable features.

My experience showed that the weight estimating techniques we have today are somewhat difficult for our engineers to specifically identify the weight savings available throughout the use of composite materials. Since the modern aircraft are moving to 20% - 40% composites by weight, accurate estimates are critical.

The low observable requirements drive weight into subsystem and components at a rate, heretofore not experienced. The actuators, for example, may become heavier and more complex because there can be little outer mold line relief to accommodate a single straight forward design. Blade seals for doors were not used before, and a simple series of holes for venting and drains is now replaced with pumps and tubes to collect and expel and airplane's internal flotsam and jetson.

As a process to verify our process, one could use the current weight estimating tools and techniques, predict the weight of the B-2 and F-117, then compare that to actuals, then compute the F-22 from the ATF prototype, and then project the F-22's eventual weight.

Please propose a lead person, your recommended approach, and a time line to complete (including the ASD-TR publication).

w Tech 2

18 February 1992

MEMORANDUM FOR ASD/ENF (Mr Dave LeMaster)

SUBJECT: Mass Properties Prediction Assessment (Horizon Action Item)

1. **Background:**

a. In late January, Mr John Griffin (ASD/EN) spoke with Mr Phil Panzarella (AFSC/EN) on the subject action item. Mr Griffin indicated that ASD/EN would assess current processes and methodologies for calculating mass properties and identify improvements.

b. Mr Griffin outlined a possible approach for addressing this issue (attachment 1) and requested that ASD/ENF take the lead in developing a formal approach and conducting a study. Mr Griffin has requested that the final report be published as an ASD Technical Report.

c. Mr Howard Wood tasked ASD/ENFS to work this item and I've participated in one meeting with a team Mr Charles Woodcock assembled. In response to an AFSC/EN request for a preliminary plan for accomplishing the study, we provided the charts and a letter signed by Col Madden (attachment 2) to Capt Vaccaro (AFSC/EN staff) on 7 February 1992.

2. ASD/ENF is scheduled to brief Mr Griffin on this subject at 1000 - 1100 on 21 February 1992. Along with the briefing, the approach for accomplishing the tasking should be documented in a charter for Mr Griffin's signature. A draft charter for this action was provided to ENFSS on 7 January 1992.

3. I recommend that the charter developed by the ENF team be provided to ENO by COB 20 February 1992 in order that Mr Griffin can review it prior to the briefing. If the proposed briefing time is not acceptable, please advise.

Tim Jennewine
Tech Ops Staff

2 Atch
1. Mr Griffin's Notes
2. Preliminary Planning Charts

APPENDIX B

CHARTER
FOR
LOW OBSERVABLES/ADVANCED MATERIALS
WEIGHT CAPABILITY ASSESSMENT

Purpose:

To conduct an assessment of weights prediction methodology as applied to low observables technologies and the use of advanced materials. Deficiencies, strengths, and limitations are to be identified with recommendations for correction and improvement.

Team Authority:

This team is chartered under the authority of ASD/EN. The responsible organization is ASD/ENFS (Structures Division of the Flight Systems Directorate). The team leader is Mr Thomas Oole of ASD/SDE; principle members of the team are:

Mr Tom Oole	ASD/SDE	Team Lead
Mr Wayne Raney	ASD/ENFSS	Team Secretariat
Mr Dan Sheets	ASD/SDE	
Mr Irv Schaff	ASD/YSEF	
Mr Greg Bonardi	ASD/YFEF	
Lt Andy Batten	ASD/ENFSS	
Mr Robert Anderson	WL/XPAD	

General Approach:

A sound and proven weight prediction procedure for a conceptual aircraft design will be followed. Methods tentatively deemed applicable to the system to be analyzed will be surveyed and compiled with requisite technical data researched. The resultant mix of methods appropriately modified will then be applied to the subject aircraft with limitations and deficiencies to the approach noted and cross-checked with actual weights. Identified shortcomings will be corrected where feasible and reapplied in an iterative process. The results with recommendations for applications and improvements will be documented.

Interfaces:

This assessment will require the cooperation of several program offices and a moderate amount of engineering support from within those program offices to assist the team in obtaining the necessary data.

Product:

A technical report will be published describing the methods and procedures used, applications, comparison of calculated values for a variety of aircraft, including but not limited to the F-117, B-2 and the F-22, and recommendations for improvement of the total process. As required, briefings to ASD/EN will be scheduled to provide status updates.

Schedule:

The total time required to complete the assessment and document the results in a report for ASD/EN approval is estimated to be six months. The distribution of time has been allocated in the following manner:

Methods Requirements-Data Collection	20-30 working days
Perform Weight Analysis	40-50 working days
Document	40-50 working days

Howard A. Wood

HOWARD A. WOOD
Technical Director
Flight Systems Engineering
DCS, Integrated Engineering
and Technical Management

APPENDIX C: MEMORANDUM FOR THE RECORD - MEETING MINUTES

MEMORANDUM FOR THE RECORD 27 Mar 92

SUBJECT: Minutes of the Low Observables/Advanced Materials Weights Capability Assessment Team Meeting

1. On 27 Mar 92, an Assessment Team Meeting was held with Tom Oole, Bob Anderson, Greg Bonardi, Dan Sheets, Lt Andy Batten and Wayne Raney. The following was discussed:

a. Bob Andersons' Memo for Record to ASD/EN (Mr Griffin), 24 Mar 92. Additional action is deferred until such time as is further directed.

b. A near final copy of the required methodology parameters list has been given to the B-2 and F-117 offices. F-22 was the originator.

c. Lt Batten has begun writing the introduction and other preliminaries to the projected TR.

d. Most Form 398s and PARs have been received by the SPOs and are in work.

e. Access to the F-22 office has been delayed by personnel unavailability. Greg Bonardi is to expedite procedures.

f. Transcribing methodologies into computer files is in work by Lt Batten.

g. It is hoped to make the team meetings a weekly affair, meeting every Friday. Team member scheduling and availability will be the deciding factors.

2. Any questions on this subject may be directed to either Tom Oole, SDE, 56582 or Wayne Raney, ENFSS, 54487.

WAYNE RANEY
Secretariat

cc: ASD/EN (Mr Griffin)
ASD/ENF (Mr Wood)
ASD/SDE (Mr Oole)
ASD/ENFS (Mr Petrin)
ASD/ENFSS (Mr Woodcock)

Memorandum for the Record 3 April 1992

Subject: Minutes of the Second Meeting of the Weights Capability Assessment Team

1. On 3 April 1992, an Assessment Team Meeting was held with Tom Oole, Bob Anderson, Irv Schaff, Dan Sheets, Lt Andrew Batten, and Wayne Raney attending. The following was discussed:

a. Questions from the F-117 and B-2 regarding the methodology parameters list. Separate meetings to explain and elaborate have been scheduled.

b. Tom Oole, Bob Anderson, and Irv Schaff have been briefed into the F-117. Greg Bonardi to follow in the near future.

c. Oole, Anderson, and Dan Sheets tentatively scheduled to be briefed into the B-2 on Tuesday.

d. Lt Batten and Wayne Raney are in the process of updating their security clearances. Ms Sharon Talbot of ENO has been instrumental in answering questions and clearing up problems in this area.

e. Access to the F-22 office continues to be delayed by personnel unavailability. It is expected that these difficulties will be resolved by next week.

f. It is anticipated that a preliminary assessment of the F-22 will begin next week.

2. Any questions on this subject may be directed to either Tom Oole, SDE, 56582 or Wayne Raney, ENFSS, 54487.

WAYNE RANEY
Secretariat

CC: ASD/EN (Mr Griffin)
ASD/ENF (Mr Wood)
ASD/SDE (Mr Oole)
ASD/ENFS (Mr Petrin)
ASD/ENFSS (Mr Woodcock)

Memorandum for the Record 13 April 1992

Subject: Minutes of the Third Meeting of the Weights Capability Assessment Team

1. On 10 April 1992, an Assessment Team Meeting was held with Tom Oole, Bob Anderson, Irv Schaff, Dan Sheets, and Lt Andrew Batten attending. The following was discussed:

a. Tom Oole and Bob Anderson have been briefed into the B-2 SPO. Greg Bonardi and Dan Sheets are pending.

b. Bob Anderson to begin collecting F-22 data this week.

c. Still trying to get the Mil Spec on writing TRs. Anderson is working.

d. Lt Batten has completed draft outlines of the Notice, Forward, Abstract, Table of Contents, Introduction and Discussion sections for the TR.

e. Due to personnel unavailability, there will not be a meeting next Friday, 17 April 1992.

2. Any questions on this subject may be directed to either Tom Oole, SDE, 56582 or Wayne Raney, ENFSS, 54487.

Wayne Raney

WAYNE RANEY
Secretariat

CC: ASD/EN (Mr Griffin)
ASD/ENF (Mr Wood)
ASD/SDE (Mr Oole)
ASD/ENFS (Mr Petrin)
ASD/ENFSS (Mr Woodcock)

Memorandum for the Record 28 April 1992

Subject: Minutes of the Fourth Meeting of the Weights Capability Assessment Team

1. On 24 April 1992, an Assessment Team Meeting was held with Tom Oole, Bob Anderson, Irv Schaff, and Wayne Raney attending. The following was discussed:

a. Bob Anderson, Dan Sheets, Irv Schaff, and Tom Oole are to meet sometime next week to study methodology parameter listings and to determine what parameter values will need to be researched.

b. 24 March 1992 letter from Steve Hickey and the proposed response were discussed at length. Steve Hickeys' letter is attached.

c. Copies of the TR Notice, Forward, Abstract, Table of Contents, Introduction and Discussion draft outlines were distributed for review and comment.

2. Any questions on this subject may be directed to either Tom Oole, SDE, 56582 or Wayne Raney, ENFSS, 54487.

WAYNE RANEY
Secretariat

1 Atch
YF(FF) Ltr, 24 Mar 92

cc: ASD/EN (Mr Griffin)
ASD/ENF (Mr Wood)
ASD/SDE (Mr Oole)
ASD/ENFS (Mr Petrin)
ASD/ENFSS (Mr Woodcock)

DEPARTMENT OF THE AIR FORCE

HEADQUARTERS AERONAUTICAL SYSTEMS DIVISION (AFSC)
WRIGHT-PATTERSON AIR FORCE BASE, OHIO 45433-6503

24 MAR 1992

FROM: YF (FF)

SUBJECT: Low Observables/Advanced Materials Weight Capability Assessment

TO: ASD/ENFZ (Mr H. Wood)

1. We concur with the objective of this charter. However, we have the following comments that may result in further expansion of the charter and the workload of the team. My comments are:

a. The weight assessment should be performed and correlated to the first production model of several "conventional" aircraft such as the F-15A, F-16A, C-5A, and the B1B. This is felt to be necessary to validate and provide confidence in the basic parametric methods. These methods can be corrected for composite materials or for observables considerations.

b. Normally, a weight growth rate is assumed and applied to the parametric weight submitted with the proposal. This growth rate can be anywhere from 5 to 8 percent. What weight does this parametric weight predict? If the parametric weight accurately predicts the weight of the first production vehicle, why is a growth rate necessary? If a growth rate is required, can a value be recommended based on some sort of metric or rationale?

c. There should be considerable attention placed on estimating the subsystem weights on a parametric basis. This is one of the softest areas in the weight estimation process.

2. The validation of parametric weights is an excellent idea, but as was pointed out during the F-22 source selection, there was no weight control program in place. Upon further research, it was found that the weight control plan is a Contracts Data Requirements List item and is, therefore, different for every airplane. This is an opportune time for this group of experts to put together a boilerplate or MIL-Prime Mass Properties Control Plan. (Mr Bonardi can be of help here because he researched this subject and provided the strawman for the F-22 Mass Properties Control Plan.) This plan is as important, or more important, than the validation of parametrics weight estimation.

3. The prediction of the F-22 weight must be complete by early April 1992 to support an early May 1992 performance assessment. However, due to the sensitivity of the data and the immaturity of the design, the F-22 System Program Office (SPO) would allow the weight (and center-of-gravity) to be estimated by only Mr G. Bonardi and Mr R. Anderson and briefed to ASD/EN, but not included in the final report.

4. Unfortunately, due to heavy SPO commitments, Mr Bonardi will only be able to support this effort on a time-available basis.

HERBERT J. HICKEY
Chief, Flight Systems Team
Air Vehicle IPT
F-22 System Program Office

I NOTE THERE IS NO REVIEW PLANNED OF THE A-12. I RECOMMEND THAT THIS BE INCLUDED IN THE DATA BASE.

Memorandum for the Record F.F.th 1 May 1992

Subject: Minutes of the Fourth Meeting of the Weights Capability Assessment Team

1. Due to personnel unavailability, an Assessment Team Meeting was not held 1 May 1992. However, the following occured this past week.

a. Bob Anderson, Dan Sheets, and Irv Schaff have begun to analyze methodology parameters with a view to identify those needing additional research.

b. The adaption of the methodology for B-2 peculiarities has begun by Bob Anderson.

c. Wayne Raney's security update forms have been forwarded to Ms Sharon Talbot of ENO. Lt Batten's are to follow.

d. Draft response of YF(FF) letter (see Minutes of Fourth meeting memo, 28 Apr 92, reviewed and commented on by Mr Woodcock of ENFSS and acting for ENFS and Mr Wood of ENF. Revised version in typing.

2. Any questions on this subject may be directed to either Tom Oole, SDE, 56582 or Wayne Raney, ENFSS, 54487.

Wayne Raney

WAYNE RANEY
Secretariat

cc: ASD/EN (Mr Griffin)
ASD/ENF (Mr Wood)
ASD/SDE (Mr Oole)
ASD/ENFS (Mr Petrin)
ASD/ENFSS (Mr Woodcock)

Memorandum for the Record 11 May 1992

Subject: Minutes of the Sixth Meeting of the Weights Capability Assessment Team

1. Due to personnel unavailability, an Assessment Team Meeting was not held 8 May 1992. However, the following occured this past week.

a. Analysis of the B-2 has begun. Methodology is being fine tuned by application to B-2 subsystems.

b. F-22 and F-117 are correlating data in anticipation of methodology application.

c. Effort was begun on response to Mr Panzerella's request for status update.

d. Access to the F-22 remains in work.

2. Any questions on this subject may be directed to either Tom Oole, SDE, 56582 or Wayne Raney, ENFSS, 54487.

WAYNE RANEY
Secretariat

cc: ASD/EN (Mr Griffin)
ASD/ENF (Mr Wood)
ASD/SDE (Mr Oole)
ASD/ENFS (Mr Petrin)
ASD/ENFSS (Mr Woodcock)

Memorandum for the Record 15 May 1992

Subject: Minutes of the Seventh Meeting of the Weights Capability Assessment Team

1. Due to personnel unavailability, an Assessment Team Meeting was not held 15 May 1992. However, the following occured this past week.

a. Analysis of the B-2 continues.

b. Lt Batten's security clearance update forms have been completed and will be sent to ENO next week.

c. Access to the F-22 remains limited. Attempts to work the issue have been considerably slowed by communication problems.

d. Preliminary effort on a status update for Mr Griffin has begun.

2. Any questions on this subject may be directed to either Tom Oole, SDE, 56582 or Wayne Raney, ENFSS, 54487.

WAYNE RANEY
Secretariat

cc: ASD/EN (Mr Griffin)
ASD/ENF (Mr Wood)
ASD/SDE (Mr Oole)
ASD/ENFS (Mr Petrin)
ASD/ENFSS (Mr Woodcock)

MEMORANDUM FOR THE RECORD 26 May 92

SUBJECT: Minutes of the Eighth Meeting of the Weights Capability Assessment Team

1. On 22 May 1992, an Assessment Team meeting was held with Tom Oole, Dan Sheets and Wayne Raney in attendance. The following was discussed:

a. Lt Batten's Form 398s have been received in the F-117 office. After review and approval, he will be in-briefed into that program.

b. Dan Sheets has taken an action item to track down two F-117 Actual Weight reports and to review the accompanying security restrictions.

c. Status update for Mr Griffin remains in work.

d. Wayne Raney's security update and thus program access is being delayed by litigation.

2. Any questions on this subject may be directed to either Tom Oole, SDE, 56582 or Wayne Raney, ENFSL, 54487.

Wayne Raney

WAYNE RANEY
Secretariat

cc: ASD/EN (Mr Griffin)
ASD/ENF (Mr Wood)
ASD/SDE (Mr Oole)
ASD/ENFS (Mr Petrin)
ASD/ENFSL (Mr Wafford)

MEMORANDUM FOR THE RECORD 2-Jun-92

SUBJECT: Minutes of the Ninth Meeting of the Weights Capability Assessment Team

1. On 29 May 1992, an Assessment Team Meeting was held with Tom Oole, Irv Schaff and Wayne Raney in attendance. The following was discussed:

a. Major March of Mr Panzerella's office called Tom Oole regarding the status of the assessment and requested a detailed schedule. A status update letter with an attached schedule for Mr Wood's signature has been drafted.

b. Bob Anderson has completed the initial assessment of the B-2s hydraulics, ECS, electrical and undercarriage groups. Work on the remaining subsystems has begun.

c. Bob Anderson (via an earlier telecon) is to coordinate with Dan Sheets on an updated parameter listing.

d. Wayne Raney's security update is still being delayed by litigation.

2. Any questions on this subject may be directed to either Tom Oole, SDE, 56582 or Wayne Raney, ENFSL, 54487.

WAYNE RANEY
Secretariat

cc: ASD/EN (Mr Griffin)
ASD/SDE (Mr Oole)
ASD/ENF (Mr Wood)
ASD/ENFS (Mr Petrin)
ASD/ENFSL (Mr Wafford)
ASD/ENFSA (Mr Woodcock)

MEMORANDUM FOR THE RECORD 5 June 1992

SUBJECT: Minutes of the Tenth Meeting of the Weights Capability Assessment Team

1. On 5 June 1992, an Assessment Team Meeting was held with Tom Oole, Bob Anderson, Dan Sheets, Lt Andy Batten and Wayne Raney in attendance. The following was discussed:

a. Bob Anderson's security situation with the F-22 office is expected to be resolved in the near future.

b. A status update letter with a detailed schedule for Mr Griffin is in coordination. In it, a request is made to forward a copy to AFSC/EN in lieu of a more direct response to Mr Panzarella's status update request.

c. Dan Sheets has found an F-117 Actual Weight Report and with Lt Batten's assistance, has begun declassification procedures.

d. Revised TR Notice, Forward, Abstract, etc. were distributed for review and comment.

e. The analysis of the B-2 primary structure has been started by Bob Anderson and Irv Schaff.

2. Any questions on this subject may be directed to either Tom Oole, SDE, 56582 or Wayne Raney, ENFSL, 54487.

WAYNE RANEY
Secretariat

cc: ASD/EN (Mr Griffin)
ASD/ENF (Mr Wood)
ASD/SDE (Mr Oole)
ASD/ENFS (Mr Petrin)
ASD/ENFSL (Mr Wafford)
ASD/ENFSA (Mr Woodcock)

MEMORANDUM FOR THE RECORD 12 June 1992

SUBJECT: Minutes of the Eleventh Meeting of the Weights Capability Assessment Team

1. On 12 June 1992, an Assessment Team Meeting was held with Tom Oole, Bob Anderson, Dan Sheets, Irv Schaff, Lt Andy Batten and Wayne Raney in attendance. The following was discussed:

a. F-117 Actual Weight Reports have been fully declassified and are being copied for distribution.

b. F-117 methodology parameters are late coming in from Lockheed. Dan Sheets is to try to expedite this.

c. Bob Anderson's name has been reinstated on the F-22s access list. Expects to be re-briefed back into the program sometime in the very near future.

d. Wayne Raney's security update remains delayed by litigation.

e. Irv Schaff and Bob Anderson have applied two separate methodologies on the B-2 landing gear, electrical and hydraulic subsystems. Two methods have also been applied and a third is in work on the B-2's primary structure.

f. Despite several delays, particularly with program access, the effort is on schedule and progressing satisfactorily.

2. Any questions on this subject may be directed to either Tom Oole, SDE, 56582 or Wayne Raney, ENFSL, 54672.

WAYNE RANEY
Secretariat

cc: ASD/EN (Mr Griffin)
ASD/ENF (Mr Wood)
ASD/SDE (Mr Oole)
ASD/ENFS (Mr Petrin)
ASD/ENFSL (Mr Wafford)
ASD/ENFSA (Mr Woodcock)

MEMORANDUM FOR THE RECORD 23 June 1992

SUBJECT: Minutes of the Twelfth Meeting of the Weights Capability Assessment Team

1. Due to personnel unavailability, an Assessment Team meeting was not held 19 June 1992. However, the following occurred this past week.

a. The main analysis of the B-2s primary structure has been completed by Bob Anderson and Irv Schaff. Fine-tuning to account for access doors and similar openings is ongoing.

b. Bob Anderson has began a draft write up on the B-2 analysis.

c. F-22 brief-in for Bob Anderson was postponed due to personnel unavailability. It is anticipated that the brief-in will be scheduled for this upcoming week.

2. Any questions on this subject may be directed to either Tom Oole, SDE, 56582 or Wayne Raney, ENFSL, 54672.

WAYNE RANEY
Secretariat

cc: ASD/EN (Mr Griffin)
ASD/ENF (Mr Wood)
ASD/SDE (Mr Oole)
ASD/ENFS (Mr Petrin)
ASD/ENFSL (Mr Wafford)
ASD/ENFSA (Mr Woodcock)

MEMORANDUM FOR THE RECORD 26 June 1992

SUBJECT: Minutes of the Thirteenth Meeting of the Weights Capability Assessment Team

1. On 26 June 1992, an Assessment Team Meeting was held with Tom Oole, Bob Anderson, Irv Schaff, Lt Andy Batten and Wayne Raney in attendance. The following was discussed:

a. Lt Batten has been briefed into the F-117 program.

b. Need for F-117 data in greater detail was discussed. Lt Batten to work with Dan Sheets in a file search.

c. Numerous scheduling conflicts, nonavailability of resources and problems of access has created a delay in starting on the F-117 and in finishing the B-2. The assessment is currently slightly behind schedule.

2. Any questions on this subject may be directed to either Tom Oole, SDE, 56582 or Wayne Raney, ENFSL, 54672.

WAYNE RANEY
Secretariat

cc: ASD/EN (Mr Griffin)
ASD/ENF (Mr Wood)
ASD/SDE (Mr Oole)
ASD/ENFS (Mr Petrin)
ASD/ENFSL (Mr Wafford)
ASD/ENFSA (Mr Woodcock)

MEMORANDUM FOR THE RECORD 6 July 1992

SUBJECT: Minutes of the Fourteenth Meeting of the Weights Capability Assessment Team

1. Due to the holiday, an Assessment Team Meeting was not held 3 July 1992. However, the following occurred this past week.

a. B-2 analysis completed. The first draft of the writeup has been finished.

b. Review of the newly declassified F-117 weight report has begun.

c. Lockheed has sent in most of the requested methodology parameter data.

d. The assessment remains behind schedule due mainly to personnel unavailability and scheduling conflicts.

2. Any questions on this subject may be directed to either Tom Oole, SDE, 56582 or Wayne Raney, ENFSL, 54672.

Wayne Raney

WAYNE RANEY
Secretariat

cc: ASC/EN (Mr Griffin)
ASC/ENF (Mr Wood)
ASC/SDE (Mr Oole)
ASC/ENFS (Mr Petrin)
ASC/ENFSL (Mr Wafford)
ASC/ENFSA (Mr Woodcock)

MEMORANDUM FOR THE RECORD 10 July 1992

SUBJECT: Minutes of the Fifteenth Meeting of the Weights Capability Assessment Team

1. Due to personnel unavailability, an Assessment Team meeting was not held 10 Jul 92. However, the following occurred this past week.

a. Lt Batten and Dan Sheets is continuing to research F-117 data.

b. Irv Schaff has begun to apply the methodology to the F-117.

c. The B-2 writeup is being reviewed and improved upon by Bob Anderson.

d. Bob Anderson was TDY this week on the AX program with the concurrence of Mr Haas (ASC/XR) and Mr Griffin (ASC/XR). His unavailability combined with past scheduling conflicts, resource limitations and problems of access have kept the assessment behind schedule.

2. Any questions on this subject may be directed to either Tom Oole, SDE, 56582 or Wayne Raney, ENFSL, 54672.

WAYNE RANEY
Secretariat

cc: ASC/EN (Dr Halpin)
ASC/XR (Mr Griffin)
ASC/ENF (Mr Wood)
ASC/SDE (Mr Oole)
ASC/ENFS (Mr Petrin)
ASC/ENFSL (Mr Wafford)
ASC/ENFSA (Mr Woodcock)

MEMORANDUM FOR THE RECORD 20 July 1992

SUBJECT: Minutes of the Sixteenth Meeting of the Weights Capability Assessment Team

1. Due to personnel unavailability, an Assessment Team meeting was not held 17 Jul 92. With personnel in class, on vacation or directed AX assignment, no activity on the assessment occurred. The study remains behind schedule.

2. Any questions on this subject may be directed to either Tom Oole, SDE, 56582 or Wayne Raney, ENFSL, 54672.

WAYNE RANEY
Secretariat

cc: ASC/EN (Dr Halpin)
ASC/XR (Mr Griffin)
ASC/ENF (Mr Wood)
ASC/SDE (Mr Oole)
ASC/ENFS (Mr Petrin)
ASC/ENFSL (Mr Wafford)
ASC/ENFSA (Mr Woodcock)

MEMORANDUM FOR THE RECORD 27 July 1992

SUBJECT: Minutes of the Seventeenth Meeting of the Weights Capability Assessment Team

1. Due to personnel unavailability, an Assessment Team meeting was not held 24 Jul 92. With personnel TDY, on vacation or directed AX assignment, no activity on the assessment occurred. The study remains behind schedule.

2. Any questions on this subject may be directed to either Tom Oole, SDE, 56582 or Wayne Raney, ENFSL, 54672.

WAYNE RANEY
Secretariat

cc: ASC/EN (Dr Halpin)
ASC/XR (Mr Griffin)
ASC/ENF (Mr Wood)
ASC/SDE (Mr Oole)
ASC/ENFS (Mr Petrin)
ASC/ENFSL (Mr Wafford)
ASC/ENFSA (Mr Woodcock)

MEMORANDUM FOR THE RECORD 31 July 1992

SUBJECT: Minutes of the Eighteenth Meeting of the Weights Capability Assessment Team

1. Due to personnel unavailability, an Assessment Team meeting was not held 31 Jul 92. With personnel TDY, on vacation or directed AX assignment, no activity on the assessment occurred. The study remains behind schedule.

2. Any questions on this subject may be directed to either Tom Oole, SDE, 56582 or Wayne Raney, ENFSL, 54672.

WAYNE RANEY
Secretariat

cc: ASC/EN (Dr Halpin)
ASC/XR (Mr Griffin)
ASC/ENF (Mr Wood)
ASC/SDE (Mr Oole)
ASC/ENFS (Mr Petrin)
ASC/ENFSL (Mr Wafford)
ASC/ENFSA (Mr Woodcock)

MEMORANDUM FOR THE RECORD 11 August 1992

SUBJECT: Minutes of the Nineteenth Meeting of the Weights Capability Assessment Team

1. On 7 August 1992, an Assessment Team Meeting was held with Tom Oole and Wayne Raney in attendance. During the meeting, draft briefing charts for Dr. Halpin were examined and changes discussed. These charts are being modified prior to a final review by the entire team.

2. Due to directed AX assignment, TDYs, classes and vacations, the study remains behind schedule.

3. Any questions on this subject may be directed to either Tom Oole, SDE, 56582 or Wayne Raney, ENFSL, 54672.

WAYNE RANEY
Secretariat

cc: ASC/EN (Dr. Halpin)
ASC/XR (Mr. Griffin)
ASC/ENF (Mr. Wood)
ASC/ENO (Ms. Bailey)
ASC/SDE (Mr. Oole)
ASC/ENFS (Mr. Petrin)
ASC/ENFSL (Mr. Wafford)
ASC/ENFSA (Mr. Woodcock)

MEMORANDUM FOR THE RECORD 17 August 1992

SUBJECT: Minutes of the Twentieth Meeting of the Weights Capability Assessment Team

1. An Assessment Team meeting was not held 14 August 1992. However, the following occurred this past week.

a. Bob Anderson has announced his retirement from the Federal service effective 21 August 1992.

b. Tom Oole, Irv Schaff and Lt. Batten have begun the analysis of the F-117.

c. Due to schedule conflicts and personnel unavailability, the study remains behind schedule.

2. Any questions on this subject may be directed to either Tom Oole, SDE, 56582 or Wayne Raney, ENFSL, 54672.

WAYNE RANEY
Secretariat

cc: ASC/EN (Dr. Halpin)
ASC/XR (Mr. Griffin)
ASC/ENF (Mr. Wood)
ASC/ENO (Ms. Bailey)
ASC/SDE (Mr. Oole)
ASC/ENFS (Mr. Petrin)
ASC/ENFSL (Mr. Wafford)
ASC/ENFSA (Mr. Woodcock)

MEMORANDUM FOR THE RECORD 24 August 1992

SUBJECT: Minutes of the Twenty-First Meeting of the Weights Capability Assessment Team

1. An Assessment Team meeting was not held 21 August 1992. However, the following occurred this past week.

a. An introductory/status briefing was given by Tom Oole to Dr. Halpin. Howard Wood, John Wafford, Debbie Bailey and Wayne Raney were in attendance.

b. Briefing charts for an anticipated 8 September 1992 presentation to Otha B. Davenport were drafted and discussed.

c. Irv Schaff, Lt. Batten and Tom Oole are continuing to analyze the F-117.

2. Due to reasons previously discussed, the study remains behind schedule.

3. Any questions on this subject may be directed to either Tom Oole, SDE, 56582 or Wayne Raney, ENFSL, 54672.

WAYNE RANEY
Secretariat

cc: ASC/EN (Dr. Halpin)
ASC/XR (Mr. Griffin)
ASC/ENF (Mr. Wood)
ASC/ENO (Ms. Bailey)
ASC/SDE (Mr. Oole)
ASC/ENFS (Mr. Petrin)
ASC/ENFSL (Mr. Wafford)
ASC/ENFSA (Mr. Woodcock)

MEMORANDUM FOR THE RECORD 31 August 1992

SUBJECT: Minutes of the Twenty-Second Meeting of the Weights Capability Assessment Team

1. An Assessment Team meeting was not held 28 August 1992. However, Irv Schaff and Lt. Batten continue to analyze the F-117.

2. Due to reasons previously discussed, the study remains behind schedule.

3. Any questions on this subject may be directed to either Tom Oole, SDE, 56582 or Wayne Raney, ENFSL, 54672.

WAYNE RANEY
Secretariat

cc: ASC/EN (Dr. Halpin)
ASC/XR (Mr. Griffin)
ASC/ENF (Mr. Wood)
ASC/ENO (Ms. Bailey)
ASC/SDE (Mr. Oole)
ASC/ENFS (Mr. Petrin)
ASC/ENFSL (Mr. Wafford)
ASC/ENFSA (Mr. Woodcock)

MEMORANDUM FOR THE RECORD 11 Sep 92

SUBJECT: Minutes of the Twenty-Third Meeting of the Weights Capability Assessment Team

1. An Assessment Team meeting was not held 4 Sep 92. However, review of the draft briefing charts for the 10 Sep 92 presentation to Mr. Panzarella continues. Also, Lockheed has been requested to provide additional F-117 data.

2. For reasons presented in past memorandums, the study remains behind schedule.

3. Any questions on this subject may be directed to either Tom Oole, SDE, 56582 or Wayne Raney, ENFSL, 54672.

WAYNE RANEY
Secretariat

cc: ASC/EN (Dr. Halpin)
ASC/XR (Mr. Griffin)
ASC/ENF (Mr. Wood)
ASC/ENO (Ms. Bailey)
ASC/SDE (Mr. Oole)
ASC/ENFS (Mr. Petrin)
ASC/ENFSL (Mr. Wafford)
ASC/ENFSA (Mr. Woodcock)

MEMORANDUM FOR THE RECORD 15 Sep 92

SUBJECT: Weekly Activity Report for the Weights Capability Assessment Effective 8-11 Sep 92

1. The following occurred this past week:

a. A status briefing was given to Mr. Panzarella (HQ AFMC/EN) by Tom Oole on 10 Sep 92. Otha Davenport, Howard Wood, Clovis Petrin, John Wafford, Al Gonsiska and Wayne Raney were in attendance.

b. Several recommendations/suggestions were received from Mr. Panzarella including:

(1) Include computer, floor space and security arrangement needs in final report and briefing.

(2) ASC/XR needs to have someone replace the retired Bob Anderson in both function and background.

(3) Additional effort is to be made to acquire A-12 data for assessment.

(4) A recommendation in the final report/briefing that a weight overage risk management/abatement plan be required and be reviewable during source selection.

(5) Another recommendation for the final report may be allocation of additional resources to the labs to better define and predict the newer technologies.

(6) The F-22 is to be deleted from consideration.

c. Tentative plans have been made to brief General Franklin either in late October or early November.

d. Due to briefing preparations, no progress was made on the assessment effort itself.

2. Any questions on this subject may be directed to either Tom Oole, SDE, 56582 or Wayne Raney, ENFSL, 54672.

WAYNE RANEY
Secretariat

cc: ASC/EN (Dr. Halpin)
ASC/XR (Mr. Griffin)
ASC/ENF (Mr. Wood)
ASC/ENO (Ms. Bailey)
ASC/SDE (Mr. Oole)
ASC/ENFS (Mr. Petrin)
ASC/ENFSL (Mr. Wafford)
ASC/ENFSA (Mr. Woodcock)

MEMORANDUM FOR THE RECORD 21 Sep 92

SUBJECT: Weekly Activity Report for the Weights Capability Assessment Effective 14-18 Sep 92

1. The following occurred this past week:

a. A meeting with Howard Wood was held 18 Sep 92 with Tom Oole, Clovis Petrin, Al Gonsiska and Wayne Raney in attendance. The following was discussed:

(1) General ideas and philosophy for the projected briefing to General Franklin.

(2) Time frames for run-throughs of the briefing for Dr. Halpin and Mr. Panzarella. This will remain highly dependent upon not only Assessment progress, but also upon Dr. Halpin's and Mr. Panzarella's schedules.

(3) Mr. Wood wishes specifically to see C-17 data, a "step by step" approach and the identification of a methodology focal point or the lack thereof in the briefing.

b. ASC/YSEF has agreed to let Irv Schaff work on the Assessment exclusively six hours a day for a period of three weeks beginning 21 Sep 92.

2. Any questions on this subject may be directed to either Tom Oole, SDE, 56582 or Wayne Raney, ENFSL, 54672.

WAYNE RANEY
Secretariat

cc: ASC/EN (Dr. Halpin)
ASC/XR (Mr. Griffin)
ASC/ENF (Mr. Wood)
ASC/ENO (Ms. Bailey)
ASC/SDE (Mr. Oole)
ASC/ENFS (Mr. Petrin)
ASC/ENFSL (Mr. Wafford)
ASC/ENFSA (Mr. Woodcock)

MEMORANDUM FOR THE RECORD 28 Sep 92

SUBJECT: Weekly Activity Report for the Weights Capability Assessment Effective 21-25 Sep 92

1. The following occurred this past week:

a. Tom Oole, Irv Schaff and Lt Andy Batten continue to analyze the F-117. Information, specifically drawings, on the empennage is lacking. Further requests will be made this week to Lockheed to provide this data.

b. Efforts are being made to procure an Actual Weight Report of a production standard C-17. This data and the earlier weight estimates may be included in the TR and final briefing.

2. Any questions on this subject may be directed to either Tom Oole, SDE, 56582 or Wayne Raney, ENFSL, 54672.

Wayne Raney

WAYNE RANEY
Secretariat

cc: ASC/EN (Dr. Halpin)
ASC/XR (Mr. Griffin)
ASC/ENF (Mr. Wood)
ASC/ENO (Ms. Bailey)
ASC/SDE (Mr. Oole)
ASC/ENFS (Mr. Petrin)
ASC/ENFSL (Mr. Wafford)
ASC/ENFSA (Mr. Woodcock)

MEMORANDUM FOR THE RECORD 6 Oct 92

SUBJECT: Weekly Activity Report for the Weights Capability Assessment, Effective 28 Sep - 2 Oct 92

1. Analysis of the F-117 by Tom Oole and Irv Schaff continues. Parameter data for the empennage remains lacking.

2. Any questions on this subject may be directed to either Tom Oole, SDE, 56582 or Wayne Raney, ENFSL, 54672.

WAYNE RANEY
Secretariat

cc: ASC/EN (Dr. Halpin)
ASC/XR (Mr. Griffin)
ASC/ENF (Mr. Wood)
ASC/ENO (Ms. Bailey)
ASC/SDE (Mr. Oole)
ASC/ENFS (Mr. Petrin)
ASC/ENFSL (Mr. Wafford)
ASC/ENFSA (Mr. Woodcock)

MEMORANDUM FOR THE RECORD 13 Oct 92

SUBJECT: Weekly Activity Report for the Weights Capability Assessment, Effective 5-9 Oct 92

1. The following occurred this past week:

a. Analysis of the F-117 continues with an expected completion date of 13 Oct 92. Evaluation of the empennage is being done with current available data as the requested drawings from Lockheed have not arrived.

b. A C-17 Actual Weight Report was procured for inclusion into the study as per Mr. Wood's request.

2. It is anticipated that work on the General Franklin briefing can begin 19 Oct 92.

3. Any questions on this subject may be directed to either Tom Oole, SDE, 56582 or Wayne Raney, ENFSL, 54672.

WAYNE RANEY
Secretariat

cc: ASC/EN (Dr. Halpin)
ASC/XR (Mr. Griffin)
ASC/ENF (Mr. Wood)
ASC/ENO (Ms. Bailey)
ASC/SDE (Mr. Oole)
ASC/ENFS (Mr. Petrin)
ASC/ENFSL (Mr. Wafford)
ASC/ENFSA (Mr. Woodcock)

MEMORANDUM FOR THE RECORD 20 Oct 92

SUBJECT: Weekly Activity Report for the Weights Capability Assessment, Effective 13-16 Oct 92

1. The following occurred this past week:

a. Analysis of the F-117 has been completed. Lacking detailed drawings, the empennage was evaluated with the best available data.

b. Work was started on the briefing. It is anticipated that a preliminary draft will be available for review towards the end of the week 19-23 October.

2. Any questions on this subject may be directed to either Tom Oole, SDE, 56582 or Wayne Raney, ENFSL, 54672.

Wayne Raney

WAYNE RANEY
Secretariat

cc: ASC/EN (Dr. Halpin)
ASC/XR (Mr. Griffin)
ASC/ENF (Mr. Wood)
ASC/ENO (Ms. Bailey)
ASC/SDE (Mr. Oole)
ASC/ENFS (Mr. Petrin)
ASC/ENFSL (Mr. Wafford)
ASC/ENFSA (Mr. Woodcock)

MEMORANDUM FOR THE RECORD 29 Oct 92

SUBJECT: Weekly Activity Report for the Weights Capability Assessment, Effective 19-23 Oct 92

1. The week was spent preparing and reviewing the projected General Franklin briefing. It is anticipated that a run-through with Dr. Halpin can be made next week.

2. Any questions on this subject may be directed to either Tom Oole, SDE, 56582 or Wayne Raney, ENFSL, 54672.

Wayne Raney

WAYNE RANEY
Secretariat

cc: ASC/EN (Dr. Halpin)
ASC/XR (Mr. Griffin)
ASC/ENF (Mr. Wood)
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ASC/SDE (Mr. Oole)
ASC/ENFS (Mr. Petrin)
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ASC/ENFSA (Mr. Woodcock)

MEMORANDUM FOR THE RECORD 4 Nov 92

SUBJECT: Weekly Activity Report for the Weights Capability Assessment, Effective 26-30 Oct 92

1. A run-through of the projected General Franklin briefing was given to Dr. Halpin on 28 Oct 92. In addition to Howard Wood, Clovis Petrin, Tom Oole, John Wafford, Irv Schaff and Wayne Raney, there were representatives from the LO and avionics disciplines present.

2. It is anticipated that the affected SPOs will be briefed sometime next week.

3. Any questions on this subject may be directed to either Tom Oole, SDE, 56582 or Wayne Raney, ENFSL, 54672.

Wayne Raney

WAYNE RANEY
Secretariat

cc: ASC/EN (Dr. Halpin)
ASC/XR (Mr. Griffin)
ASC/ENF (Mr. Wood)
ASC/ENO (Ms. Bailey)
ASC/SDE (Mr. Oole)
ASC/ENFS (Mr. Petrin)
ASC/ENFSL (Mr. Wafford)
ASC/ENFSA (Mr. Woodcock)

MEMORANDUM FOR THE RECORD 9 Nov 92

SUBJECT: Weekly Activity Report for the Weights Capability Assessment, Effective 2-6 Nov 92

1. Courtesy presentations of the Franklin briefing was given to the B-2, F-117 and C-17 SPO's. Later, classified discussions using the actual and estimated weights were held with the B-2 and F-117.

2. It is currently scheduled that the briefing incorporating pertinent SPO comments will be given to Dr. Halpin on 20 Nov 92.

3. Any questions on this subject may be directed to either Tom Oole, SDE, 56582 or Wayne Raney, ENFSL, 54672.

WAYNE RANEY
Secretariat

cc: ASC/EN (Dr. Halpin)
ASC/XR (Mr. Griffin)
ASC/ENF (Mr. Wood)
ASC/ENO (Ms. Bailey)
ASC/SDE (Mr. Oole)
ASC/ENFS (Mr. Petrin)
ASC/ENFSL (Mr. Wafford)
ASC/ENFSA (Mr. Woodcock)

MEMORANDUM FOR THE RECORD 13 Nov 92

SUBJECT: Weekly Activity Report for the Weights Capability Assessment, Effective 9-13 Nov 92

1. Due to TDYs, the holiday and scheduling, no activity on the Assessment occurred.

2. Any questions on this subject may be directed to either Tom Oole, SDE, 56582 or Wayne Raney, ENFSL, 54672.

WAYNE RANEY
Secretariat

cc: ASC/EN (Dr. Halpin)
ASC/XR (Mr. Griffin)
ASC/ENF (Mr. Wood)
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ASC/ENFS (Mr. Petrin)
ASC/ENFSL (Mr. Wafford)
ASC/ENFSA (Mr. Woodcock)

MEMORANDUM FOR THE RECORD 1 Dec 92

SUBJECT: Weekly Activity Report for the Weights Capability Assessment, Effective 16-20 Nov 92

1. Presentation of the revised briefing was given to Dr. Halpin on 20 Nov 92. With further minor revisions, this briefing is anticipated to go to Mr. Panzarella (HQ AFMC/EN) on 18 Dec 92.

2. Mr. Petrin of ASC/ENF has prepared a staff summary sheet for Dr. Halpin's signature outlining the Assessment Study activities, conclusions, recommendations and projected briefings.

3. Any questions on this subject may be directed to either Tom Oole, SDE, 56582 or Wayne Raney, ENFSL, 54672.

WAYNE RANEY
Secretariat

cc: ASC/EN (Dr. Halpin)
ASC/XR (Mr. Griffin)
ASC/ENF (Mr. Wood)
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ASC/SDE (Mr. Oole)
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ASC/ENFSL (Mr. Wafford)
ASC/ENFSA (Mr. Woodcock)

MEMORANDUM FOR THE RECORD 26 Jan 93

SUBJECT: Weights Assessment Presentation to General Franklin

1. General Franklin (AFPEO/TA) was given the concluding briefing for the Weights Capability Assessment on 25 Jan 93. The presentation was favorably received with additional tasking to further define resources needed to support the recommendations of the briefing.

2. The Technical Report on the Assessment effort is in work and is to be the closure event of the study. Implementation of the Assessment's recommendations are a separate activity and beyond the scope of the study effort.

3. Any questions on this subject may be directed to either Tom Oole, SDE, 56582 or Wayne Raney, ENFSL, 54672.

WAYNE RANEY
Secretariat

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