Engineering Management
Field Project

Strategic Plan for Utilizing Low Cost Engineering Resources at Generic Aerospace

By

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Executive Summary

In the past, businesses have used several different options in an effort to alleviate engineering resource constraints. These included use of contract engineers, overtime of employees, or utilization of sister facilities resources. All of these methods are costly and may cause other issues, such as inconsistent output, high turnover and resource constraints for other sites. One concept that is being more readily adopted is the use of Low Cost Engineering Services (LCES) offered by third party suppliers. This method allows companies to utilize additional resources using several different strategies. For instance, for long term projects, a company can use dedicated resources that only work on a specific project. For short term projects, a company can develop a Statement of Work that outlines a given set of hours and expected deliverables. The multiple options allow companies to outsource more work and to get quicker turn around on work packages, such as, engineering analysis or product design. In addition, this practice allows companies to leveraging prices to reduce design and development costs. This strategy offers flexible resource assignment and commitment.

For the project reviewed, the objective for the management team is to implement the use of Low Cost Engineering Services for the engineering group. The management team identified the non core competency types of work that could be sent to the Low Cost Engineering Service resources. Work from the engineering and product development groups includes:

- Engineering change support
- Legacy 2D to 3D CAD conversion
- Drawing creation
- New Product Development
- Engineering Analysis

- Customer Support Documentation (Component Maintenance Manuals)

The LCES initiative will allow the design and development engineering teams to focus on developing products and improving core engineering competencies. Moving the above mentioned topics to an LCES, removes the non core competencies of drafting, drawing changes, legacy conversions and technical document creation, thereby reducing the workload of the design engineering departments and decrease turnaround time on delivery. This will also allow a reduction in costs spent creating drawings, legacy parts and Design Change Request support.

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List of Principle Symbols, Abbreviations and Nomenclature

CAD- Computer Aided Design

CFD- Computational Fluid Dynamics

CMM- Component Maintenance Manual

DCR- Design Change Request

DCN- Design Change Notice

DRR- Design Record Release

FEA- Finite Element Analysis

LCES- Low Cost Engineering Service

LCC- Low Cost Country

SOW- Statement of Work

PLM- Product Lifecycle Management

R&D- Research and Development

Chapter 1- Introduction

The business strategy to outsource work to reduce cost typically has been limited to service functions, such as, data call centers and routine business processes. This strategy for outsourcing allowed companies to be competitive by reducing costs in labor and customer support. Until recently, outsourcing of specialized services, like engineering and product development, were not supported because of the challenges with communication and data sharing. Additional barriers included time zone differences, language barriers, lack of highly-skilled workers and technology roadblocks. These challenges are increasingly eliminated through advances in file and data sharing, development of support resources in different companies and a better educated labor force. Businesses are now re-evaluating engineering and product development processes and identifying methods for those activities to be outsourced or off shored to reduce cost, increase production and decrease the time to introduce new products into the market.

The United States is not the only country reviewing how to utilize emerging markets as a source of Low Cost Engineering Services. "In 2007, the Global Engineering R&D spend by private corporations in high-cost locations (primarily North America, Europe & Australia) was estimated to be around U.S. $560 Billion. This spend is projected to increase to U.S. $886 Billion by 2020 with hi-tech industry leading the way" (Company 2008). Because of these increases, American, European and Australian companies are going to be looking for ways to cut R&D cost to remain competitive in a growing world market. The demand by investors to increase revenue and pressure of competition in the world market are forcing companies to look for new ways to cut costs and decrease time to market with new products. "There are additional

factors that make U.S. companies the number one outsource of engineering activities. Some of these factors are:

- Continuous pressure from Wall Street to cut costs and improve efficiency;
- Drive growth by tapping into emerging markets
- Less stringent labor laws (than Europe);
- Increasing confidence in supply base; and
- Positive reputation of low cost engineers in the U.S." (Company 2008)

The emerging markets, or Low Cost Countries (LCC), most utilized by high cost established markets are China and India. Both of these countries offer a talent pool rich in engineering disciplines and low-cost solutions. India is by far the most utilized Low Cost Engineering Country because of the prevalence of English speakers, the largest talent pool of educated engineers with higher degrees and a foundation of established business practices in the customer service industry, along with other past business outsourcing successes (Company 2008). Although India and China have been successful in past outsourcing practices, there are still several challenges for outsourcing Engineering Services. The type of work must be reviewed carefully to ensure there are well defined and established processes.

For outsourcing of engineering work to be successful, the process must be well defined and the statement of work must define the requirements and deliverables. Because many engineering projects require collaboration between other engineers and customers on the project, choosing work of this nature to be outsourced may be difficult to successfully complete. There are many types of work that can be outsourced with great results and little interaction between in house resources and outsourced resources. These examples include, but are not limited to:

- Legacy drawing revision

- CAD file conversions
- 3D modeling
- FEA and other type of analysis
- Technical Documents

These are proven to be successful because they do not require special knowledge requirements or special training for the project. For example, legacy drawing conversions are straight forward changes that are accompanied by the red line change of the original document scoping the work required for the change. The procedure leaves little to no question about what is needed to complete the work request and the desired result. Mature processes that are well established and well defined are the ones that will be the most successful, cost effective and time efficient.

Project Scope for Low Cost Engineering Service Initiative

To ensure a company can remain competitive and cost effective, the utilization of Low Cost Engineering Service resources must be a business goal and must have support from the management team for the outsourcing activity to be successful. The strategy should include utilization of specific partnered suppliers. This allows the companies to develop relationships that foster an effective and beneficial process. In addition, the company should also review other outsourcing companies to help alleviate resource restrictions as needed to level load projects and resource requirements.

Chapter 2- Literature Review

Introduction:

Increasingly more common is the utilization of Low Cost Engineering Services for businesses to remain competitive globally and financially. There are several reasons why this business strategy is gaining in popularity. "First, companies have realized they need to focus on their core competencies and strategic advantages. Second, suppliers are focusing on being outsource providers and doing a better job at those specialties that are non-core to the client" (Curtis 2003). By outsourcing the non-core competency work, a major cost savings is realized. In addition, more time can be spent by the in-house engineers to design and develop products.

This literature review will summarize the benefits, challenges and cost of utilizing Low Cost Engineering Services. In the following literature review, sources have been researched and cited that best describes the importance of each topic.

2.1 Cost of Outsource Engineering Services

Demands by investors and consumer markets to cut costs, increase quality and provide the latest technology are increasingly challenging to businesses because of the flattening of the world market. Research and development costs were roughly U.S. $560 Billion and predicted to rise to roughly U.S. $886 Billion in 2020. "The demand for engineering off shoring across the globe is expected to grow to ~U.S. $150 Billion by 2020" (Company 2008). Outsourcing to emerging markets like India and China will be a key driver to cost savings and tapping into resource pools of trained and educated engineers and scientists.

The cost of outsourcing is primarily the price of people completing the work in an hourly rate. "Because people are the primary cost input, engineering and design outsourcing services often priced based upon headcount (generally expressed as numbers of "full-time equivalents" or

"FTEs") or some headcount equivalent (such as hourly rates)" (Company 2008). In situations where hourly charges are billed, there must also be an agreement between parties regarding the process of correcting errors or mistakes by the responsibility of which party created the error. If the error occurred by the outsource provider, then the billable hours should be zero to correct the mistake. Another subject that must be addressed, as explored in recent studies, "What records must the service provider maintain to validate headcount charges? Working through these issues is particular important where the company has little visibility into the service providers delivery organization" (Company 2008).

Although cost is sometimes seen as the number one driver of engineering outsourcing, in reality, there are other factors to consider. It has been revealed, "contrary to popular belief, the primary driver for outsourcing does not seem to be cost" (International 2010). A primary driver of outsourcing is shifting non-core competency work to third parties so the business can focus on product development and core competency work. "While companies do want to take advantage of outsourcing at a lower cost, the priority is to maintain flexibility and outsource non core tasks and augment engineering skills to get products faster, better and cheaper to the market place" (International 2010).

2.2 Controlling Intellectual Property

Outsourcing engineering services has many challenges but one critical issue is the retention of Intellectual Property (IP). It is important to ensure the business has security of Intellectual Property and how information is shared and retained by the company and outsource provider, even when the partnership is no longer in service. "While outsourcing presents a huge opportunity beyond doubt, it also comes with its share of challenges such as IP security and communication" (International 2010). Agreements and contracts must ensure IP control is

secured by the outsource provider and their associates so information does not leak to the company's competitors.

Business agreements must be written in a way that no intellectual property is lost or shared with competitors. "In context of offshore engineering services, where the service provider staff will have access to highly confidential information or the risk of misappropriation is high, companies may want to put non-disclosure agreements in place directly with service provider personnel" (Company 2008). This may be cumbersome and hard to track but does give some protection to a company's confidential information. Because of high turnover rate, non-compete agreements directly with the LCE Service provider may also be necessary to protect a company's intellectual property from competitors.

Where concern for loss of intellectual property is high enough that non-complete and non-disclosure agreements are not enough, a company may chose to open their own facility in an emerging market to take advantage of low labor costs and less stringent labor laws. This keeps the Intellectual Property internally held by the company, while still leveraging off shore resources. "In some cases, if work content was very critical, the companies chose to take advantage of a global delivery model and executed it onsite, rather than off shoring it" (International 2010). India and China are the preferred markets for companies to set up their own engineering centers. "India, followed by China has clearly emerged as the most preferred destination when it comes to off shore engineering services or to setup captive engineering centers" (International 2010). The work is off shored to take advantage of the cost savings and collaborative 24/7 coverage of design engineering services. Additionally, since they are a part of the same company, intellectual property ownership is not an issue.

2.3 Advantages and Disadvantages of Outsourcing

There are advantage and disadvantages that must be reviewed before outsourcing processes to Low Cost Engineering Services. There are many advantages that go beyond the cost savings by outsourcing. “Multinationals are also increasingly citing strategic reasons for going off shore, such as the ability to crunch product-development time by working 24/7 with tech centers around the world” (Engardio 2006). This business model decreases time-to-market with new products and, in some cases, increased market share through the introduction of a new development ahead of competitors. As stated by James Bucki, “When done for the right reasons, outsourcing will actually help your company grow and save money. There are other advantages of outsourcing that go beyond money” (Bucki 2012). James Bucki further postulates there are seven advantages of outsourcing that must be reviewed when evaluating decisions to outsource services: “Focus on the Core Activities; Cost Efficiency Savings; Reduced Overhead; Operational Control; Staffing Flexibility; Continuity & Risk Management; Develop Internal Staff” (Bucki 2012).

These seven advantages allow internal staff to focus on core activities as the non-core related activities are completed by the outsource supplier. These advantages also detail streamlining costs and adding flexibility to staff department in work cycles. Additionally, by outsourcing, bringing the outsource engineer onsite to work alongside the internal engineers will develop new staff skill sets to improve work performance.

Although there are advantages to outsourcing services, one also must take a look at the disadvantages to determine if these services can be outsourced. As James Bucki stated “Look at each one of the outsourcing disadvantages listed below and decide what impact that item would have on your business. If the outsourcing disadvantages outweigh the advantages of outsourcing,

then you should avoid outsourcing those operations" (Bucki 2012). He states there are six disadvantages of outsourcing that must be reviewed when evaluating decisions to outsource services. Listed below are the six disadvantages of outsourcing:

"1. Loss of Managerial Control

2. Hidden Costs

3. Threat to Security and Confidentiality

4. Quality Problems

5. Tied to the Financial Well-Being of Another Company

6. Bad Publicity and Ill-Will" (Bucki 2012)

All of these disadvantages must be weighed to determine if outsourcing will benefit or cause detriment to the company and/or process. Another disadvantage to outsourcing is losing the core competencies of the internal engineering staff. "Engineering processes that are outsourced or off shored should also be evaluated for risk. The most prominent risk is the risk of losing intellectual capital- both hard intellectual property and know-how" (Company 2008).

2.4 Challenges of Selecting an Outsourcing Partner

Determining if a supplier for outsource or off shore work is suitable to meeting business needs is as important as deciding what type of engineering service to outsource. What type of qualifications or specific degree credentials will be required to perform the service? Will contractors need to have specialized training or product knowledge of the industry or business? How will the supplier record and track the right resource and have the training and knowledge needed to work on the product? Does the supplier have the equipment and skilled personnel to perform the job? These are some of the initial questions to consider and routinely monitor during

the lifetime of the partnership. “It was observed that the availability of skills is the primary driver for selecting a partner” (International 2010).

“The following five step process is indicative of the methodology that companies may want to use to select a service partner.

Step 1: Evaluate the capabilities of the vendor and short-list the potential candidates that have some experience in the industry/relevant product expertise.

Step 2: Give a pilot test(s), that is/are representative of the problems that would be solved during the performance of outsourced services, to the short-listed vendors (from step -1) and evaluate their performance. Further refine the list off capable vendors that met the pre-defined success criteria.

Step 3: Visit the operation centers of short-listed (step-2) vendors, i.e., the location where the proposed activities are to be executed, to diligence the vendors’ capabilities and review their facilities first-hand.

Step 4: Request an RFQ for the engineering activities that are planned to be outsourced or off shored from the short-listed vendors and evaluate them.

Step 5: Pick the right vendor partner based on assessments conducted in steps1-4.” (Company 2008)

Once a supplier is chosen, there is a learning curve by the supplier to develop knowledge and understanding of the company’s business practices and products. “It takes a long time to develop strong engineering capability for service providers with data centers in emerging markets” (Company 2008).

2.5 Effects of Outsourcing on U.S. Engineering Jobs

The need for outsourcing engineering services to remain competitive in the world market is on the rise and will be more prevalent in the years to come. What will this do to the U.S. engineering workforce? In a study by Peter Engardio, he explores questions raised by economists and policy makers, "Is outsourcing hurting America's engineering workforce? Or is it actually boosting engineering careers by making U.S. tech companies more competitive and allowing them to deploy engineers more effectively" (Engardio 2006)? Engardio's review of two Duke University studies reveals contrasting conclusions. The studies were completed by the Fuqua School of Business and by the Pratt School of Engineering. According to one study, "companies are going offshore because they are desperate for talent and are shifting more complex work to nations such as India and China for strategic reasons. The other Duke study concludes that the off shoring phenomenon is all about cost and that there is no shortage of engineers in the U.S. Therefore the labor shift is coming at the expense of U.S. jobs" (Engardio 2006). The Fuqua study "findings suggest that off shoring is not replacing skilled jobs in U.S. While corporations have shed workers by shifting more routine back-office processing jobs to developing nations, in three to four cases involving the off shoring of R&D and product design, no U.S. staff were fired. Indeed, companies are going abroad because they cannot find enough talent at home" (Engardio 2006), stating, "there are more than enough U.S. engineers, and companies mainly are going abroad to cut costs" (Engardio 2006). Both studies questioned businesses about how they process applicants for engineering positions. Both focused on the applicants' education levels, but one examined applicants with four-year undergraduate degrees only, while the other assessed master's and doctoral levels of education. Another is how honest the questions were answered by the companies providing the data for why they are outsourcing and the talent level they are looking for in the U.S. and off shore.

Although both studies yielded contrasting conclusions, one similarity is both studies found engineering service jobs are being outsourced. The reasons cited by companies, is either, lack of talent in the job pool or purely cost-saving reasons- both of which, current engineers need to review to secure their viability in the market place and within their company. There are steps to surviving outsourcing and what can do avoid being replaced by and low cost option. An article by Alesia Benedict states tips to surviving off shore outsourcing and what you can do to avoid losing out to outsourcing.

"Don't become a target" (Alesia Benedict 2005).

Ensure that the skills and knowledge of current business system and practices are such that they cannot afford to outsource your position. "Skills such as bilingualism, abilities with key or rare equipment, skills with software that is either so cutting-edge or so old that only a few can manipulate it well ¼ skills that will make you stand out in an ocean of other employees" (Alesia Benedict 2005).

"Move up the ladder quickly" (Alesia Benedict 2005).

The jobs that are being outsourced are the entry level jobs that have well defined process and little skill is needed to successfully complete the work. "Make it your mission to get out of that huge fish barrel of low-skilled fish and into a position that can only effectively be done on home turf as rapidly as possible. Get promoted, get higher training or education, or go for a position that is more specialized" (Alesia Benedict 2005).

"Go smaller" (Alesia Benedict 2005).

Take a position with a smaller company with a niche market that does not outsource jobs because they are dependent on close interaction with their customers. "Small companies cannot afford to

lose customers because of poor customer service or language barriers and are therefore less likely to outsource offshore" (Alesia Benedict 2005).

"Go where the jobs are" (Alesia Benedict 2005).

Go to areas where your job skill is in demand or be willing to be trained in other fields. "Workers who thrived were the ones who learned new skills that were in demand or who were willing to move to areas where their current skills were needed" (Alesia Benedict 2005).

"Stay on the cutting edge of your field" (Alesia Benedict 2005).

There is always need for skilled workers that have been trained in the latest technologies. "Work that is outsourced is generally grunt work that requires a labor force that is broadly skilled in the most common tasks, works with the most common applications, or can handle minimal communication coupled with heavy, repetitive-type work" (Alesia Benedict 2005).

Conclusion:

Outsourcing engineering services will not slow down or stop in the coming years. On the contrary, the trend is for outsourcing to be a dominant factor in the future of design engineering and development. With demands to cut cost, raise efficiency and release products to market at a faster pace, businesses need to understand how to decide what engineering processes can be successfully outsourced.

Businesses must understand what processes can be outsourced without risk to current business practice. "For engineering process to be successfully outsourced or moved off shore, it has to be well defined, process mapped, documented and standardized" (Company 2008). Processes that are poorly defined or left up to the interpretation of the outsource contractor will ultimately lead to poor results.

Choosing an outsourcing partner is important in developing a knowledge base of products and processes. A process must be followed to evaluate each supplier before choosing the one for continued partnership. There must be clearly defined expectations and goals for the partnership to remain successful. Communication is the key to developing a successful partnership along with monitoring processes and quality of service.

Because companies are looking for ways to reduce cost and increase efficiency, the low skilled, well defined engineering processes will be the first to be outsourced. Workers in these areas must be willing to continually complete training on the latest technology to avoid losing their jobs to outsourcing. One must get training in a specialized field that requires talents that cannot be outsourced.

An important aspect of outsourcing the engineering process is to ensure Intellectual Property is secure and will not be compromised by competitor. Business agreements and Non-Compete clauses must be in place for businesses and low cost engineering services to control IP. In addition, the low cost engineering service must have individual Non-Compete agreements with their associates because of high turnover rate.

Chapter 3- Procedure and Methodology

The utilization of the Low Cost Engineering Services (LCES) should be reviewed to allow it to be leveraged to its fullest extent. This service should be viewed as a resource implemented to alleviate resource constraint and as a cost-saving measure. For example, Generic Aerospace will be used as an example to outline the use of one possible LCES outsourcing strategy. Within Generic Aerospace, there are resource constraints in the Design Engineering department and management has tasked the Design Engineering Manager to review the utilization of LCES to help reduce backlog of engineering activities, resolve the resource constraints and realize a cost savings. At the completion of the project, the results will be shared with Generic Aerospace management as a model for implementation throughout the other business units. This section will cover the different types of work packages and project data packages that were identified as low risk processes that could be sent to LCES for completion.

The type of work identified as low risk processes that can be outsourced needs to meet certain classifications. This is an important activity to identify mature processes so the initiative is successful. The list below outlines the questions that should be reviewed to determine applicability for outsourcing. The list of questions is as follows:

1. Are there well defined processes in place that identify expectation and work instructions?
2. Does the work require project and customer interaction?
3. Does the work require specific product knowledge or training?
4. Can the work be completed with little interaction with internal resources?

Work packages that meet all of the requirements typically are drawing creation, drawing revision, engineering analysis, such as FEA, CFD, non-specialized projects and other mature processes with well-defined statements of work and component maintenance manuals.

External Resources:

Generic Aerospace is currently utilizing two LCES companies and has worked with one other in the past. One of the companies has an established connection with Generic Aerospace's Product Lifecycle Management (PLM) system, so data transfer is better facilitated. There is, however, a large portion of time that is invested with the transfer of data between the outsource company and Generic Aerospace. This equates to a whole resource being consumed to manage the data transfer. The other two companies are being utilized for LCES both work on a SOW basis and data is transferred via FTP sites. This again is time consuming for the internal resources to manage.

In essence, approximately half of the internal focal's time is consumed with data transfer and SOW management (such as creation and additions). To reduce this burden, remote access workstations can be utilized, which would eliminate the need for data transfer. Remote access workstations allow for all the data to reside in Generic Aerospace's database. The users employ a Remote Desktop to connect to this database and work in the Generic Aerospace virtual office. Additionally, the development of a LCES scorecard that would measure the quality of the work, timeliness, and ability to complete various work assignments would monitor quality and effectiveness of the outsource company. The scorecard will be reviewed and managed by the internal focal and the LCES companies. As potential new resource companies are identified,

work packages can be assigned and included on the scorecard, to evaluate their abilities based upon the following areas:

- Technical experience – molded parts, pressurized systems, etc.
- Engineering Knowledge and Understanding
- Technical Skills – CAD software and PLM software
- Internal resources to support increase workload
- Infrastructure to manage resources and provide daily updates
- Quality of work
- Ability to meet deadlines

Current Resources:

Current staffing and usage of the LCES is outlined below. As mentioned earlier, external resources have primarily been used on a limited basis.

Outsource #1: (Partnered LCES)

- Staff: 4 engineers (1 Full-time, 1 Full-time lead, and 2 temporary)
- Work Completed: Legacy conversions, DCR Support, and drawing creations for new programs (Internal to Site #1 PLM system)

Outsource #2: (Independent LCES)

- Staff: 2 engineers (2 located in India) and an as-needed resource (onsite or offsite) based upon SOW packages
- Work completed: Product development (includes drawings & models), FEA and Special Projects

Projected Need:

Utilizing the external resources to supplement the design and development and the production support activities, will allow Generic Aerospace to float resource allocation between different projects. The current projection would be to have eight external resources to support the needs of Generic Aerospace. This would include, at a minimum, one resource dedicated to CAD data modeling activities, one resource for electrical development (wire harness, PCB and schematics) and the remainder being focused on mechanical design.

The engineering management team would work with the respective departments (Program Management, Production and Engineering) to forecast the need for the future quarter. For example, Generic Aerospace would forecast project needs in Q412 for the Q13 projects. This forecasting would allow a balancing of resources between open and forecasted projects and enables the addition of temporary resources, if needed.

Temporary Resources:

In addition to having committed resources, there would be times when exceeding the eight resources for the sites are necessary. When this occurs, there is the option to add temporary resources with one month commitments. This would be available for Outsource #1 and Outsource #2.

Financials:

The following chart outlines the projected need of eight resources to support the design engineering activities at the Generic Aerospace. The Rate 1 and Rate 2 values are based on the current companies that we are using. A standard 2080 hours per year, per resource was used for

calculating costs. Table 3-1 shows the values used for the different labor rates. Table 3-1 shows the comparison of the total cost of each labor option.

Design Resources		FEA		Special Projects	
Internal Fully burdened	$75.95	Internal Fully burdened	$75.95	Internal Fully burdened	$75.95
Internal variable labor	$43.00	Internal variable labor	$43.00	Internal variable labor	$43.00
Rate 1	$25.00	Rate 1	$28.00	Rate 1	$25.00
Rate 2	$20.00	Rate 2	$35.00	Rate 2	$20.00

Table 3-1 Per Hour Rates

DCR/Sustaining Support/Drawing Creation					
# of Resources	Hrs per year	Internal Fully Burdened Cost/Yr	Internal Variable Cost/Yr	Rate 1Cost/yr	Rate 2 Cost/Yr
4	8320	$631,904.00	$357,760.00	$208,000.00	$166,400.00
New Product Development					
4	8320	$631,904.00	$357,760.00	$208,000.00	$166,400.00
FEA					
0.5	1040	$78,988.00	$44,720.00	$29,120.00	$36,400.00
Special Projects					
0.5	1040	$78,988.00	$44,720.00	$26,000.00	$20,800.00
Man Years	2080				

Table 3-2 Cost Comparison

The estimated saving per year for the DCR/Sustaining and new drawing creation work would be approximately $423k - $465k. If business continues to grow and new development projects continue to be awarded, then similar savings can be seen on the work for the new product development. Special Projects would realize substantial savings, approximately $24k – $58k over having internal resources complete the tasks. Another benefit of using LCES for the Special Projects is the fact that there is no internal resource shuffle to cover these needs. Internal

resources are able to stay assigned to their respective projects without interruption to their assigned tasks.

The rates for the LCE will be evaluated with the strategic purchasing team to negotiate rate reduction. This rate reduction will be expected based upon increase of work and utilization of remote access workstations.

Implementation Plan:

To facilitate supporting Generic Aerospace engineering with the LCES resources, the following items must be completed to effectively use the Low Cost Engineering Services.

- Engineering data uploaded to active PLM System.
- Remote Access to Generic Aerospace workstations to support remote users for PLM System.

Chapter 4- Results

To begin the process at Generic Aerospace, each data package or request for design engineering work is evaluated for assignment to the most effective work group. Outsource #2, works strictly on a quote package basis. A Statement of Work is created by the Generic Aerospace Offshore Coordinator, which is the focal for outside resources, who then sends the SOW package to Outsource #2 to obtain quotes. The other option is the utilization of the LCES, Outsource #1. The work flow is different for this company as they are linked in the PLM database and models and drawings are transferred digitally. For the LCES Outsource #1, there has been a standard hour's matrix created for the Offshore Coordinator to use when submitting project hours needed to complete the assigned work. As with the other outsource option, a SOW package is created through an on-line portal for assignment by the engineering lead at Outsource #1.

The engineering work packages for outsourcing fall into five main categories:

- Product Development Programs – Drawing Creation
- Product Development Programs – Design and Development
- Product Sustaining- Drawing Revision and Creation
- Special Projects- FEA, CFD and other Analysis
- Product Support Data- CMM Creation

Types of Work:

Product Development Programs – Drawing Creation

Development programs utilize in-house engineers to design and development products while interacting with system engineers to ensure the new designs meet the intended customer system requirements. This allows engineering resources to develop the design utilizing core competencies for the particular products or systems. The design engineer works with the project team to develop concept models for the various component designs. When the team determines that these units are developed enough to have drawings created, the design engineer will create a list of drawings to be completed. The design engineer will also provide any relevant data (such as, notes, similar parts and redlines) needed to complete the work. This type of request is submitted through the work request database, (see Appendix H Request for Work Database). The Design Engineering Manager will review the request for completeness of redlines and scope of work. After approval, the design request will be assigned to the Offshore Coordinator for assignment to Outsource #1 or #2. The selection of the resource will be a collaborative effort between the Focal Engineer and the Offshore Coordinator, as it will affect the project budget. The work is then assigned to the selected LCES. To ensure that all information is complete when the outsource supplier submits the work packet back to Generic Aerospace, a drawing check list

was created to ensure all work had been completed, (see Appendix I Drawing Documents Check List).

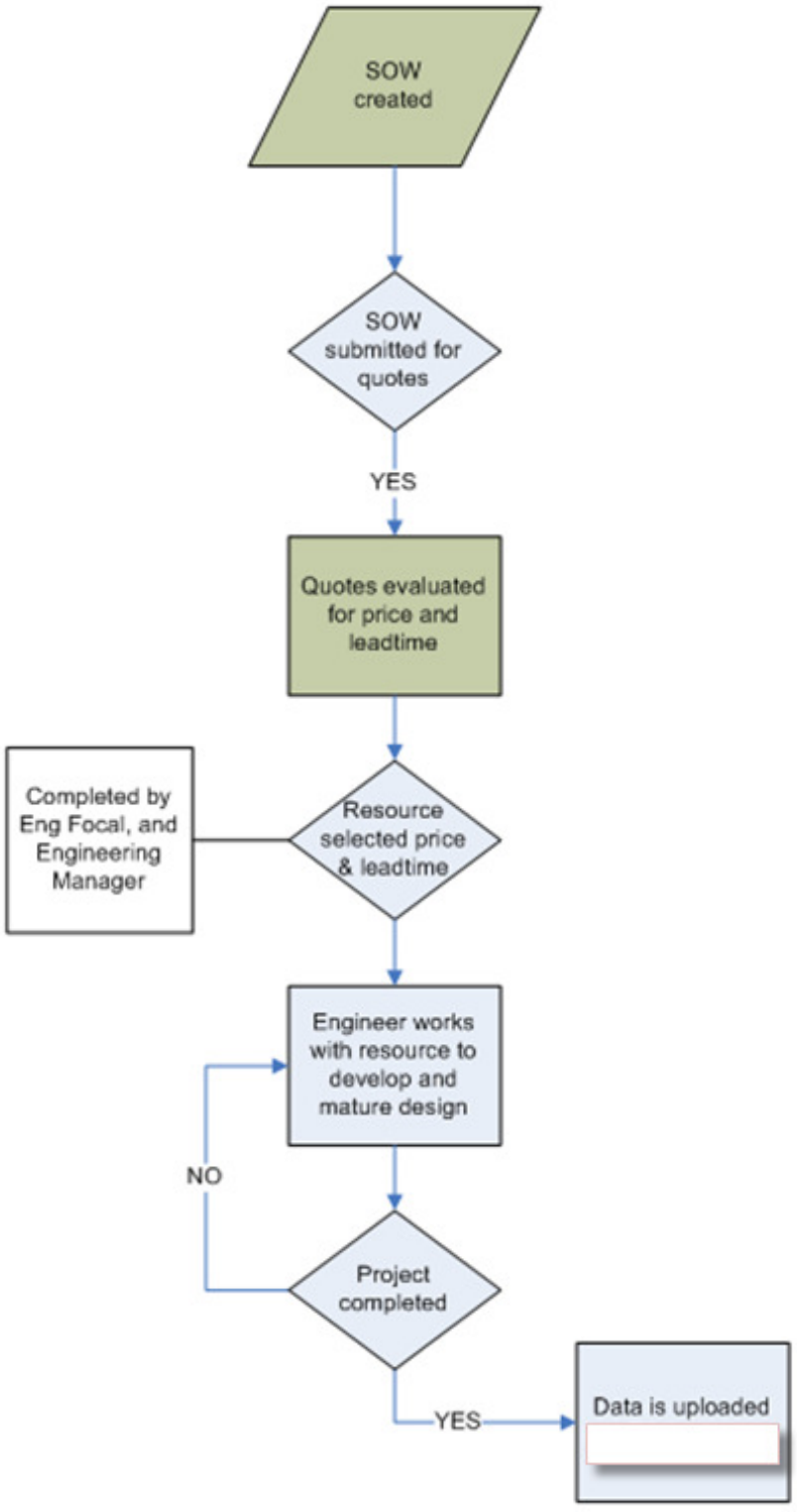

Figure 4.1 Drawing Creation

Product Development Programs – Design and Development

This process is similar to the drawing creation category except that the design work is done outside. Several factors play into this decision. First there is a lack of internal resources to support the project. Another reason is that the scope of work is outside the competency of the available resource's capability, such as in executing sweep and free form surfaces. Furthermore, if the project is small in scope and lends itself to remote management, an outside resource could be contracted to complete the task. This type of request is submitted through the work request database, (see Appendix H Request for Work Database). The Design Engineering Manager will review the request for completeness of redlines and scope of work. After approval, the design request will be assigned to the Offshore Coordinator for assignment to Outsource #1 or #2. The selection of the resource will be made as a collaborative effort between the Focal Engineer and the Offshore Coordinator, as it will affect the project budget. The work is then assigned to the selected LCES. For this type of work, the Offshore Coordinator only facilitates queries of the SOW between the Focal Engineer and outside resource. The interaction between the focal engineer and the resource is more frequent than in the drawing creation process.

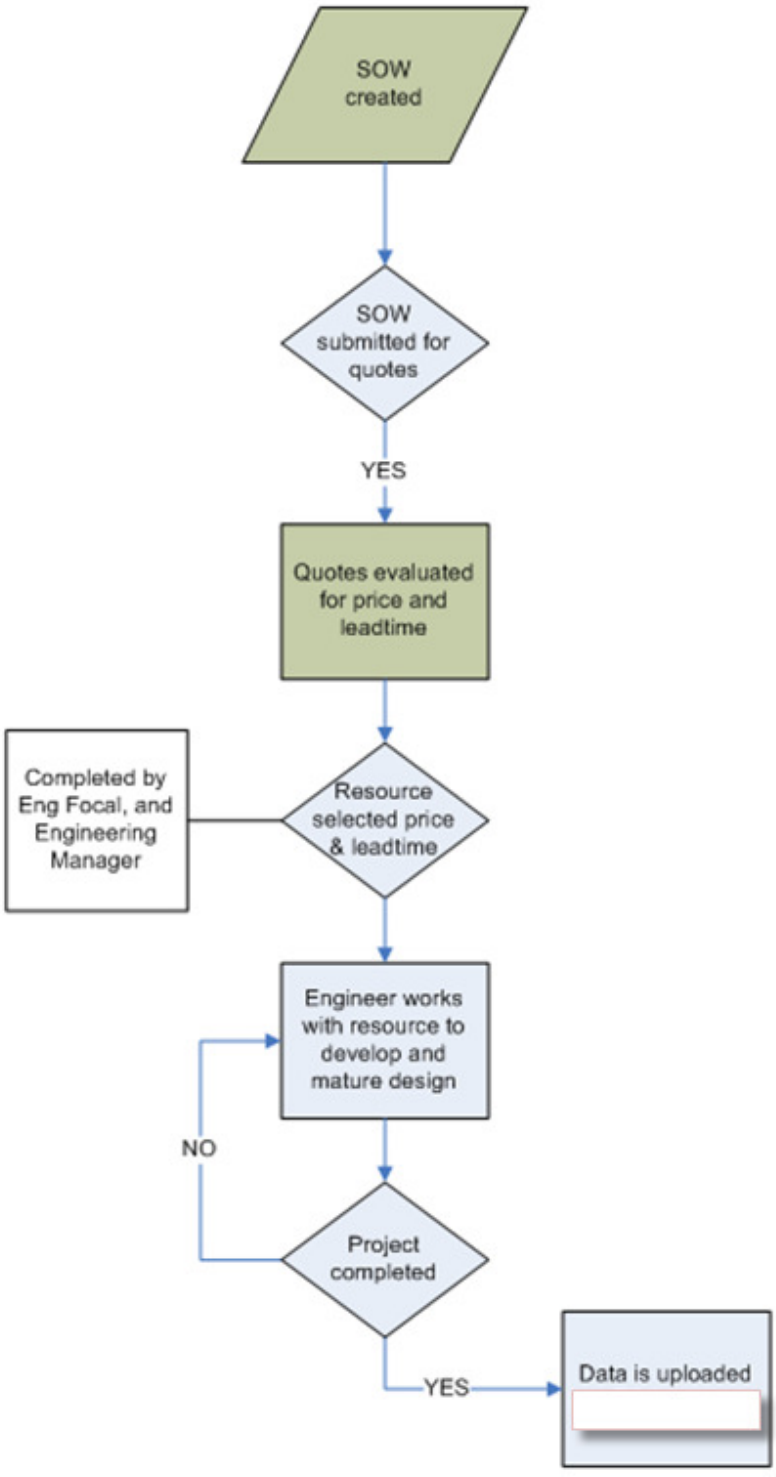

Figure 4.2 Design and Development

Product Sustaining

This type of work mainly involves drawing revisions and corrections. This type of request is submitted through the work request database, (see Appendix H Request for Work Database). The Offshore Coordinator submits the request and SOW to one of the LCES suppliers for a quote. Returned quotes are reviewed and a resource is selected to complete the work. To ensure that all information is complete when outsource supplier submits the work packet back to Generic Aerospace, a drawing check list was created to ensure all work had been completed, (see Appendix I Drawing Documents Check List). Other types of packages that fall into this category are the creation of legacy data models, which are mainly used for old 2D drawings that do not have 3D models or are not accurate to the drawing. The Offshore Coordinator will utilize only Generic Aerospace LCES, Outsource #1, for Product Sustaining work.

This type of work is assigned to Outsource #1 because they are linked in the PLM database and can utilize electronic approval workflows. Outsource #1 also has access to the released production document directory so they can track history of changes more easily than Outsource #2.

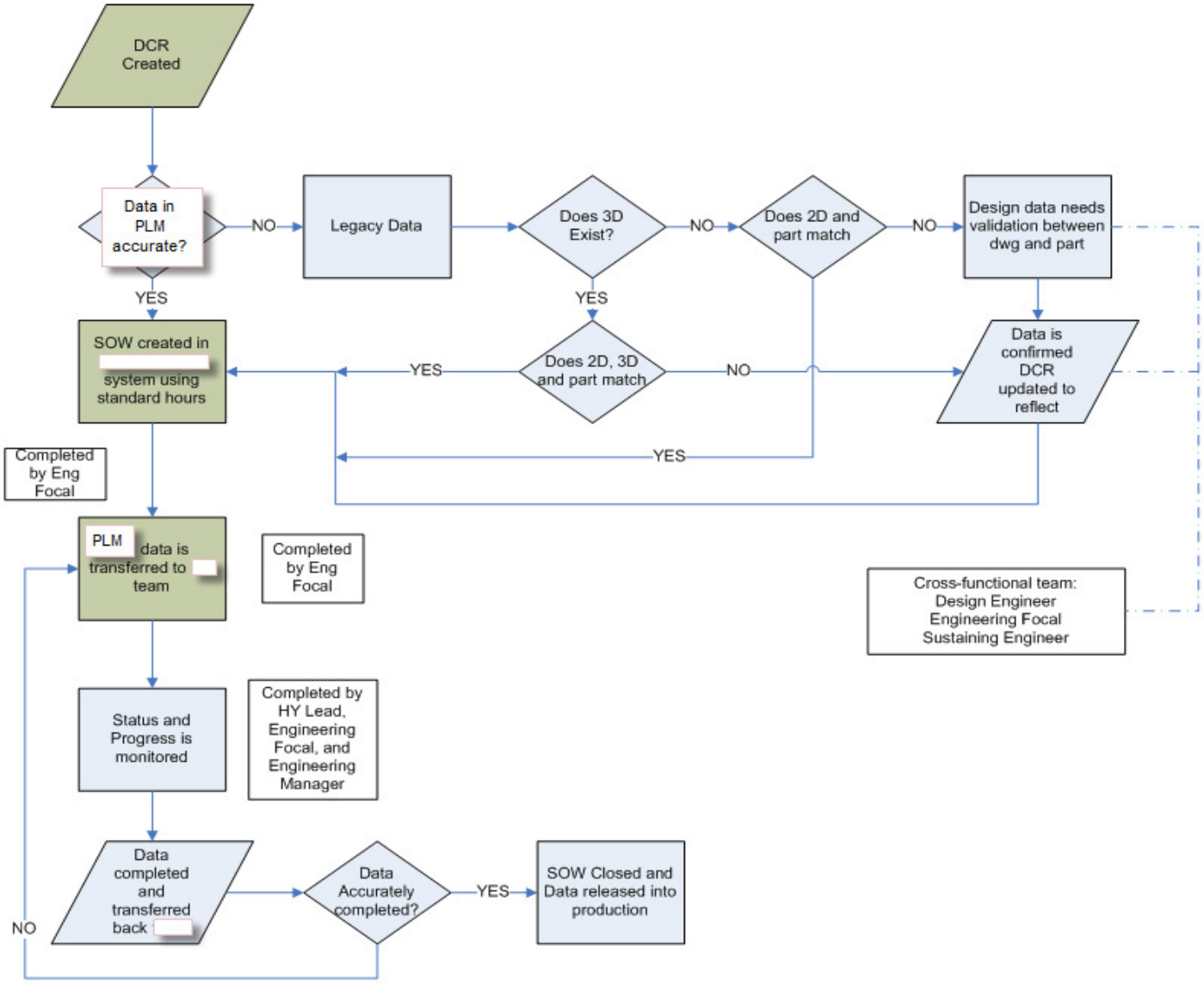

Figure 4.3 Product Sustaining

Special Projects:

Projects which are not based in the standard CAD system or Product Lifecycle Management (PLM) system are sent to outside resources utilizing the SOW and quote process. This type of request is submitted through the work request database, (see Appendix H Request for Work Database). The Offshore Coordinator submits the request and SOW to one of the LCES supplier for quoting purposes. Returned quotes are reviewed and a resource is selected to complete the work. Most of the data associated with this type of project includes Adobe Illustrator, CATIA, FEA, and other engineering analysis software. This type of work would include FEA analysis of design concepts, Catia creation or conversion, and other miscellaneous engineering work. Finite Element Analysis (FEA) has not been extensively utilized on past projects for design validation. The use of outside resources to complete this work can greatly improve the product design cycle. By incorporating engineering analysis, the engineers will be able to identify potential failures sooner and reduce the risk of failure during testing.

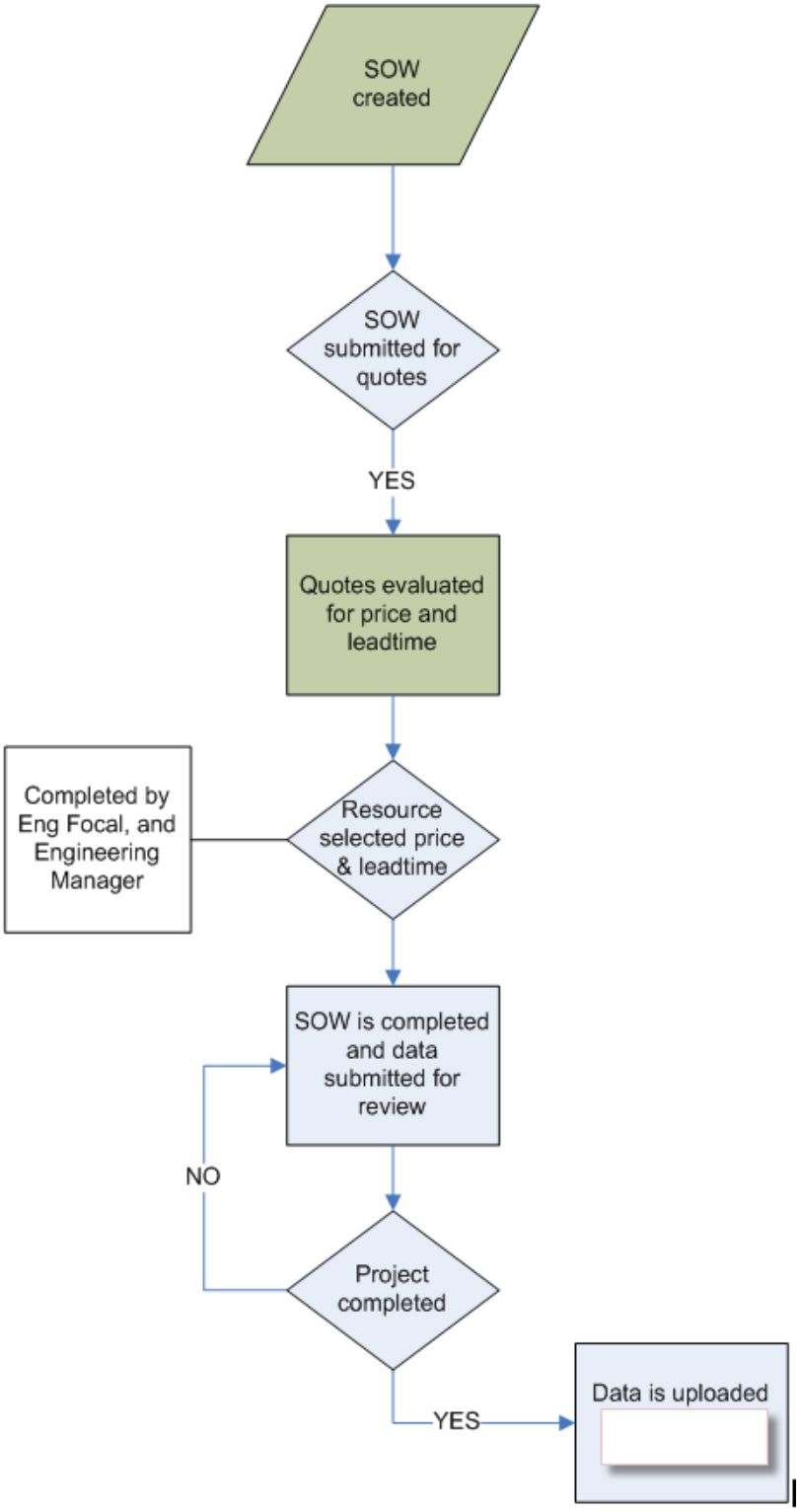

Figure 4.4 Special Projects

Product Support Data

This type of work mainly involves creation and revision of customer support documentation. These documents are the Component Maintenance Manuals (CMM) or other customer support documentation, which are used by the customer to repair and replace components used in the field. The support documents detail the product description of use, assembly, disassembly, testing and replaceable item part list. Any change to a customer end item product that affects the bill of material, acceptance testing and operation, requires a revision update to the repair manual. The process for creation and revision of support documents is well defined and details the steps required and materials needed in the process. The Offshore Coordinator will utilize only Generic Aerospace LCES, Outsource #1, for Product Support Data work.

This type of work is assigned to Outsource #1 because they are linked in the PLM database and can utilize electronic approval workflows. Outsource #1 also has access to the released production document directory so they can track history of changes more easily than Outsource #2.

To initiate work, similar to the design engineering process, a request for work will be created, (see Appendix H Request for Work Database) and sent to the Offshore Coordinator for assignment to Outsource #1. The work is assigned by the Offshore Coordinator to Outsource #1 to complete. Once Outsource #1 reviews the work packet, any questions are posed to internal Technical Writers because they retain the product knowledge of the equipment. When the work is completed by Outsource #1, the work packet is sent back to Generic Aerospace for review. Generic Aerospace Site #1 may have as many as three people reviewing and marking up the CMMs that Outsource #1 submits. To optimize the checking and approval process, a checklist was created detail the responsibilities of each department checking and reviewing the document,

see Appendix J Product Support Document Check List. When a section has several critical errors, the reviewer shall stop checking the document and note the errors found. The Outsource Writer then needs to apply the comments before reviewing the entire book. If the internal reviewer does not review a book because of systemic errors in other books, it will be noted that, for example, the "Assembly Section" was not reviewed. The Outsource Writer therefore needs to not only look at the comments made, but also decide if other errors are in the section and whether changes to other sections might be needed. Generic Aerospace requires that a maximum 10% of the pages can contain an error during the first review of a document. A second review should not contain any errors that would prevent release of the CMM. Any minor errors not incorporated in this revision would be marked up for the next time the CMM is touched. Correction of major errors identified at the second review shall be at cost of Outside Resource. A return to outsource for third review must be approved by Technical Publications Manager.

After the review at Generic Aerospace is complete; Outsource #1 provides source files and a PDF of the document. The PDF, bookmarked correctly and optimized for the web, along with all the source files, shall be transferred to Generic Aerospace no later than five days past final review. In support of data migration into the PLM System, work not yet loaded into the database will be completed by Outsource #1 and verified by Generic Aerospace Technical Publications group for future work.

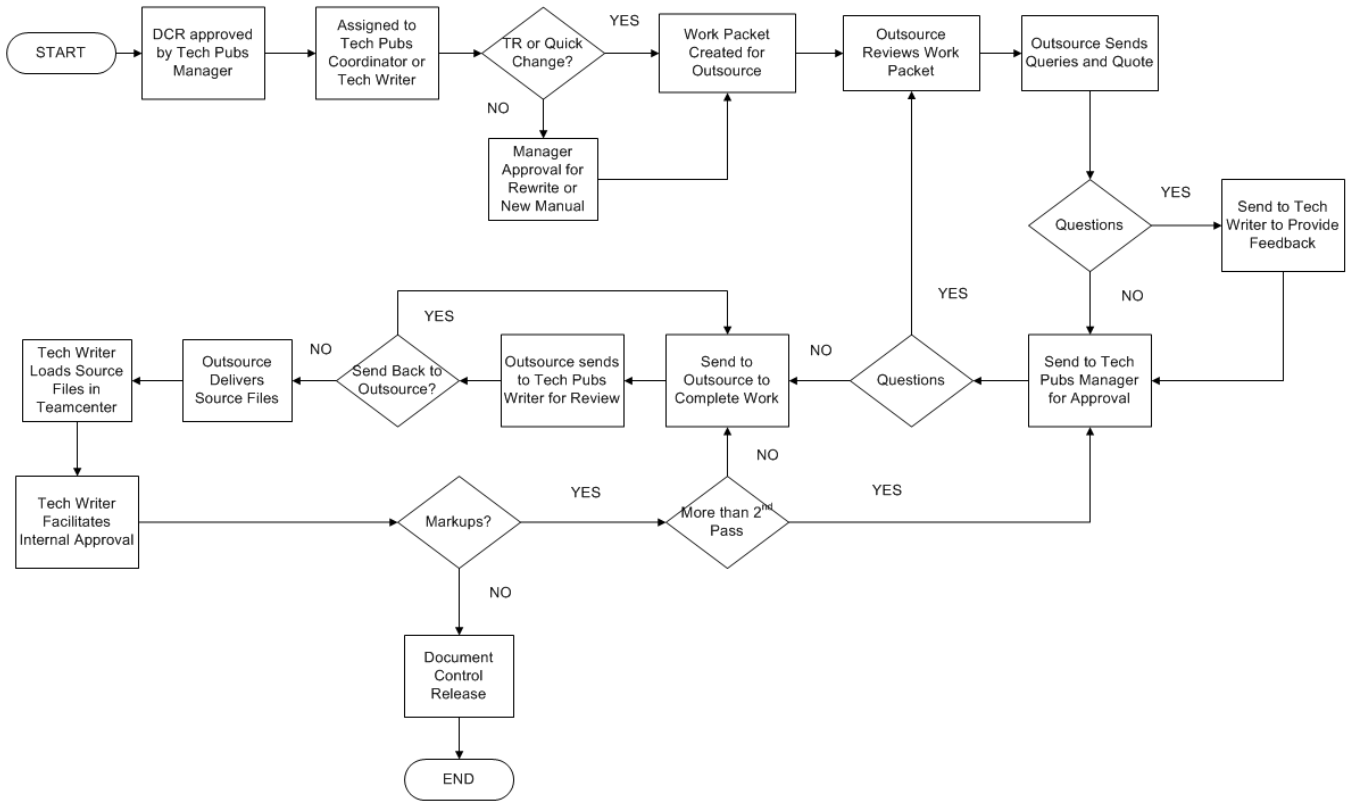

Figure 4.1 Product Support Process

To measure the work of Outsource #1 and #2, several metrics were developed. One metric was a status reporting tool, see Appendix K Offshore Tracking Database, to effectively track work assigned to LCES resources. This database tracks type of work, program, priority, status, internal and outsource resources, data assigned and data.

Metrics to track costs were also created to evaluate savings per month, see Appendix A-E. Of these metrics is the realization of actual costs versus projected costs. This metric helps better quote future projects with similar work.

Other metrics were developed to track work distribution between internal Generic Aerospace engineers and the other two LCES suppliers. This data will help better develop

capacity plans for monthly work assignments, prepare for spikes in workload and aid in determining availability of resources.

Metrics in process of development are quality metrics measuring first and second past yield, number of SOWs completed without error on time and type of work outsourced. These metrics will help better determine the gaps in the process and fix issues that lack detailed information. The measurement will also be used to monitor efficiency of LCES suppliers.

Summary:

Identifying the right processes and projects by the engineering team is crucial to successfully utilizing Low Cost Engineer Service resources. The result of successfully implementing this strategy will result in a savings for the engineering departments of up to $900k a year. This will also allow Generic Aerospace to utilize key resources to do more value added activities, such as design and development and validation of new products.

In securing a partnership with Outsource #1, the risk of utilizing the LCE Services is minimal. The risk is also low for Outsource #2, as they will be working and storing data, through remote access in Generic Aerospace's virtual office. All engineering data will remain in Generic Aerospace control through the use of the Remote Access technology. Generic Aerospace will also have the option of utilizing and evaluating other companies to ensure the development of a robust and seamless transition between the internal resources and the Low Cost Engineering Services.

Chapter 5- Suggestions for Additional Work

This project concentrated on the overall process for developing the type of work that will be outsourced to Low Cost Engineering Services. While developing this process, the need for additional research for particular areas was identified for the long term success of the project. Suggestions for future work include;

- **Development of a file sharing system to control data transfer more efficiently**

  The implementation of a PLM tool to transfer digital CAD data for creation or revision is more efficient. The electronic workflow process for digital signature approval can also be implemented to eliminate hard copy prints and scanning of wet signatures. The need for further research and develop is needed in this area to increase efficiency, create electronic workflows for approval and standardized file sharing.

- **Metrics to monitor quality, cost and on time delivery at a minimum**

  Metrics will be needed to track quality of first and second pass yield to understand the common mistakes and develop a process to fix those mistakes. One metric will be tracking cost savings to compare with internal versus external charges. Ensuring on time delivery is another important metric to ensure the outsource supplier is meeting project schedules. What other types of metrics are needed to ensure the supplier is meeting the needs of the company?

- **Standard quality and design processes**

  Standardized processes developed in collaboration with the company and outsource suppliers to increase efficiency and quality. Standard quality check procedures can be put in place for outsource suppliers to deliver ready-to-approve engineering documentation.

What are other processes and standards being developed by customers and outsource suppliers?

- **Engineering skills for internal resources**

  The type of work that will be outsourced is non core competency processes. More research may be needed on what type of skills internal engineering resource should focus on to ensure their skills will not be outsourced. This may also help determine what skills are necessary to remain internal to the company because of specialized skill or need.

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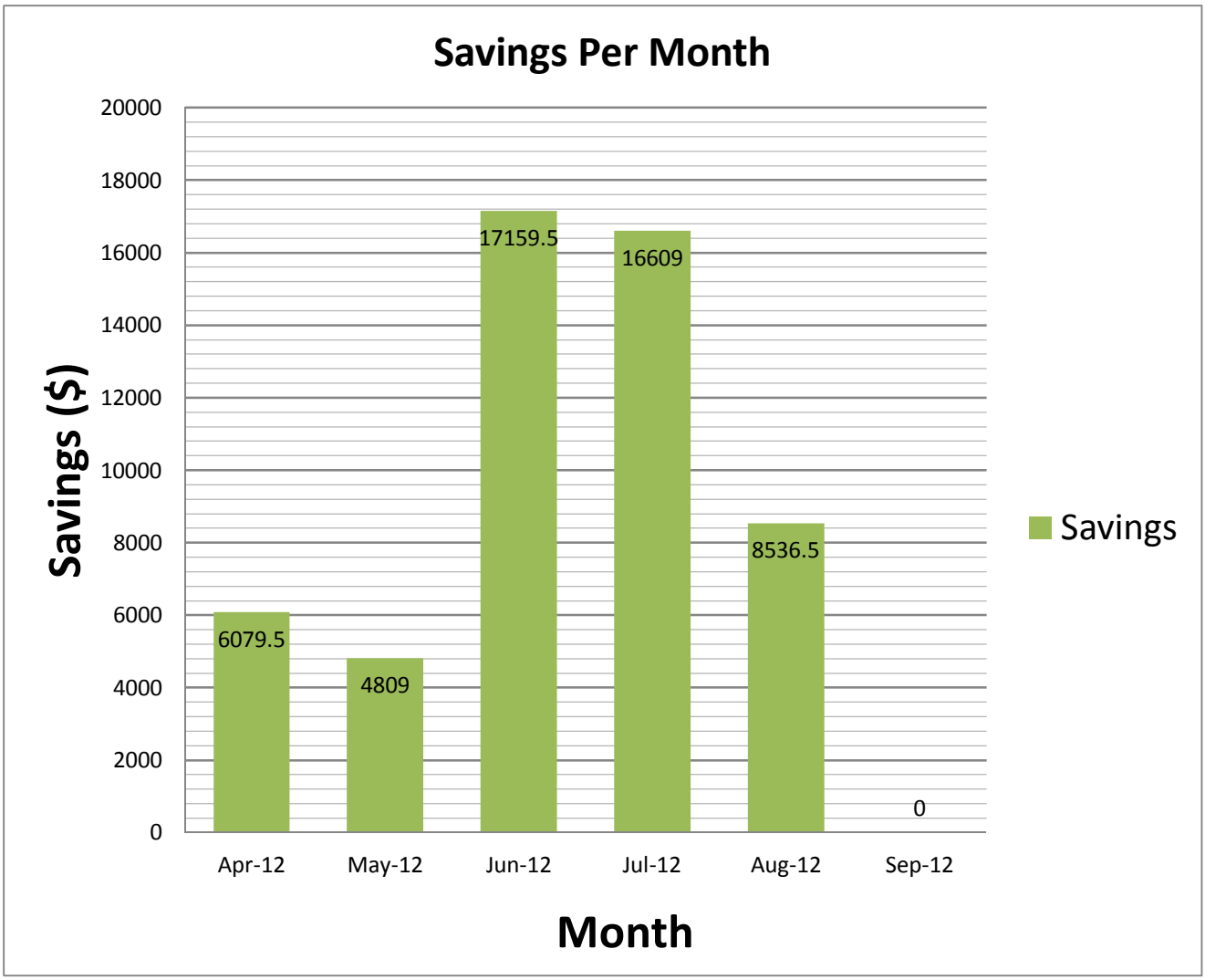
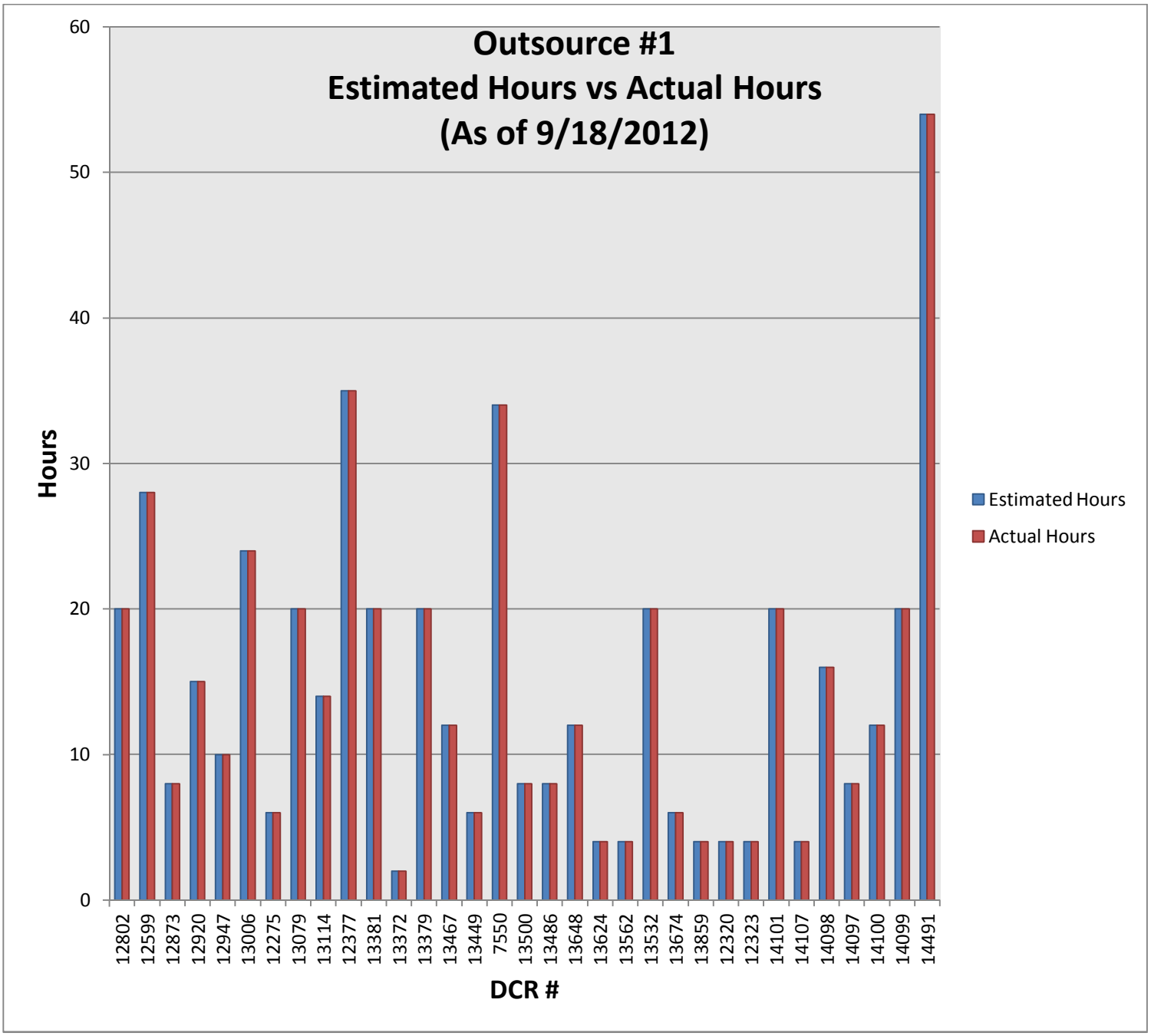
Appendices

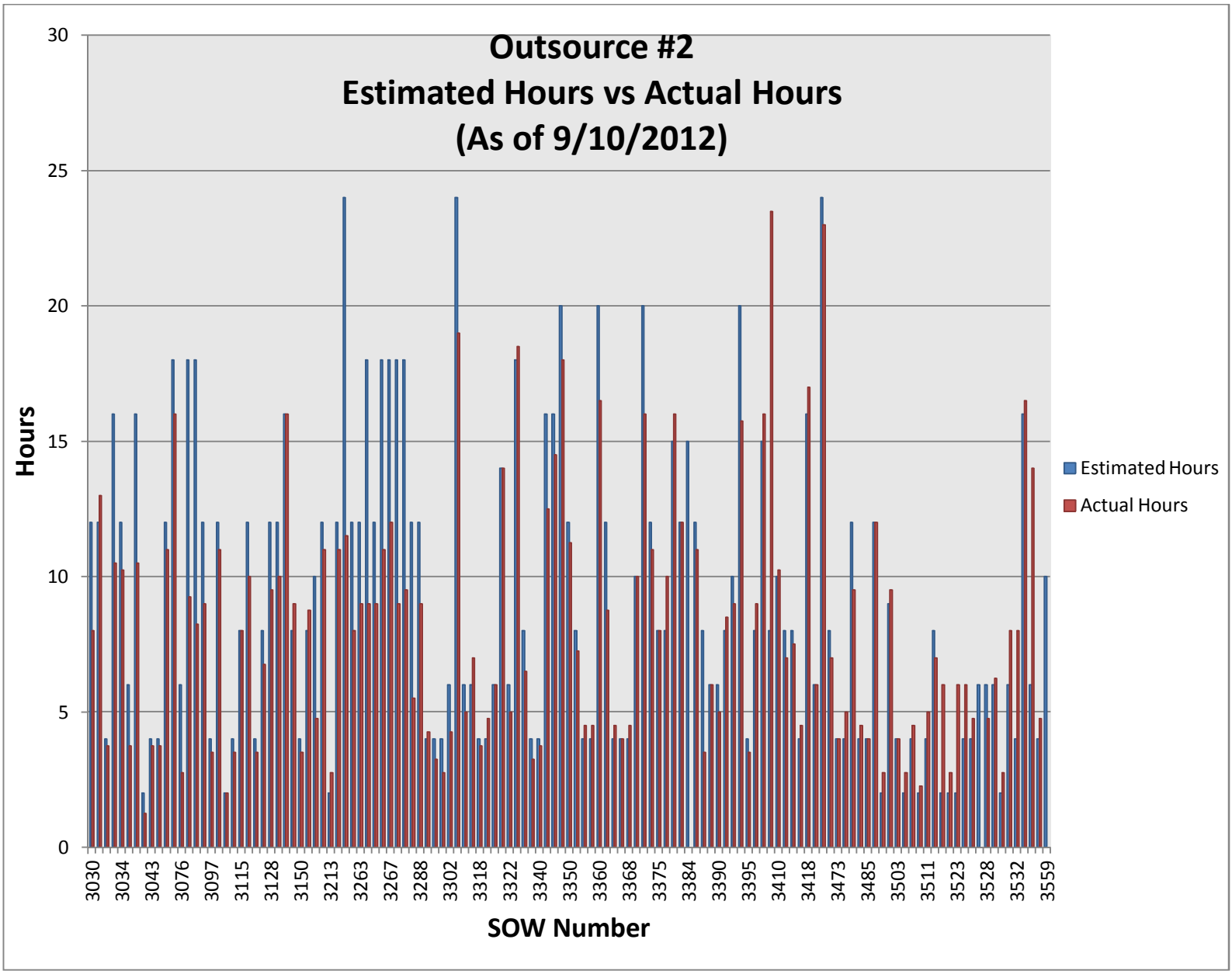
A. Cost Savings



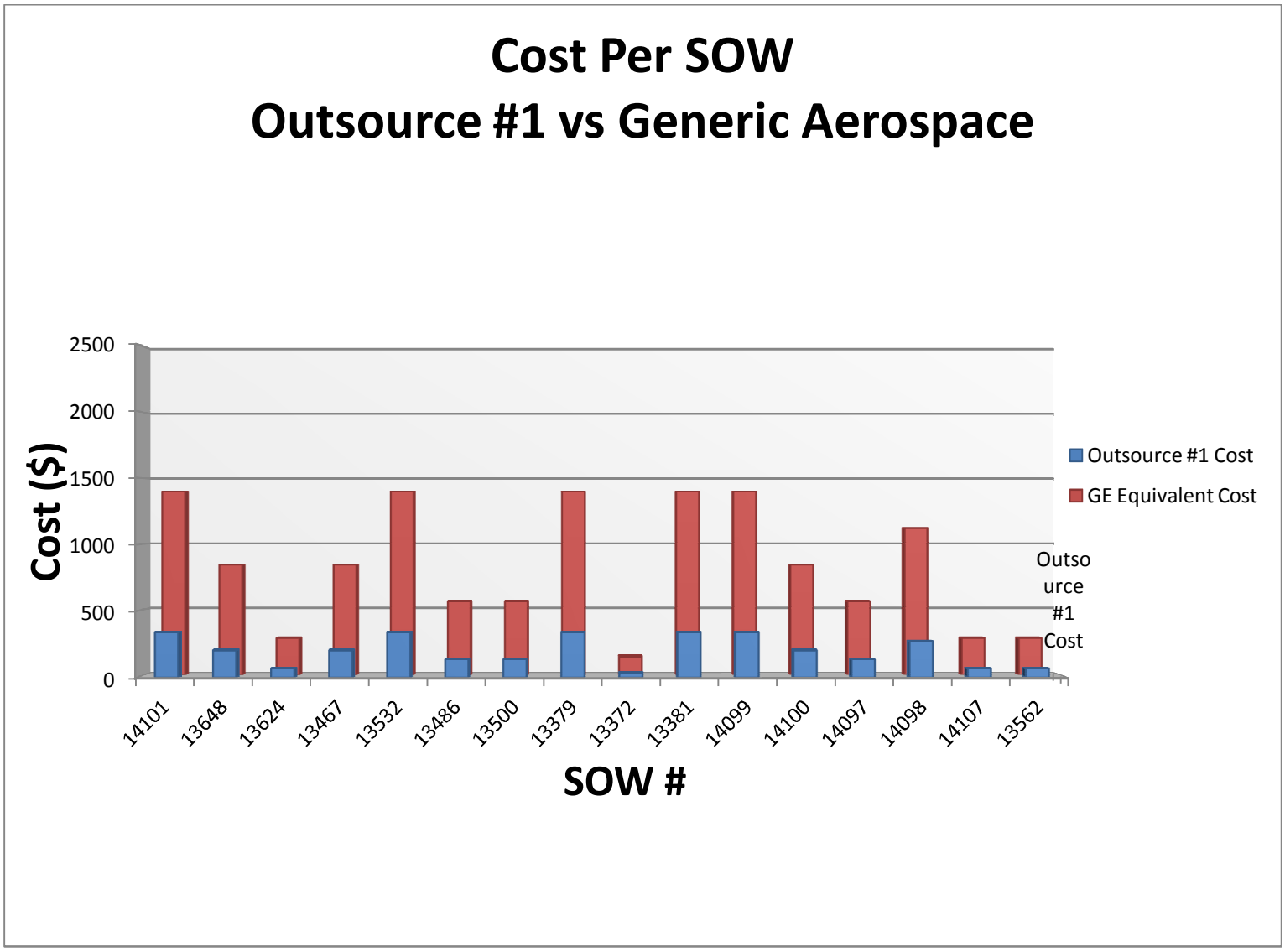
B. Outsource #1 Actual vs. Estimated



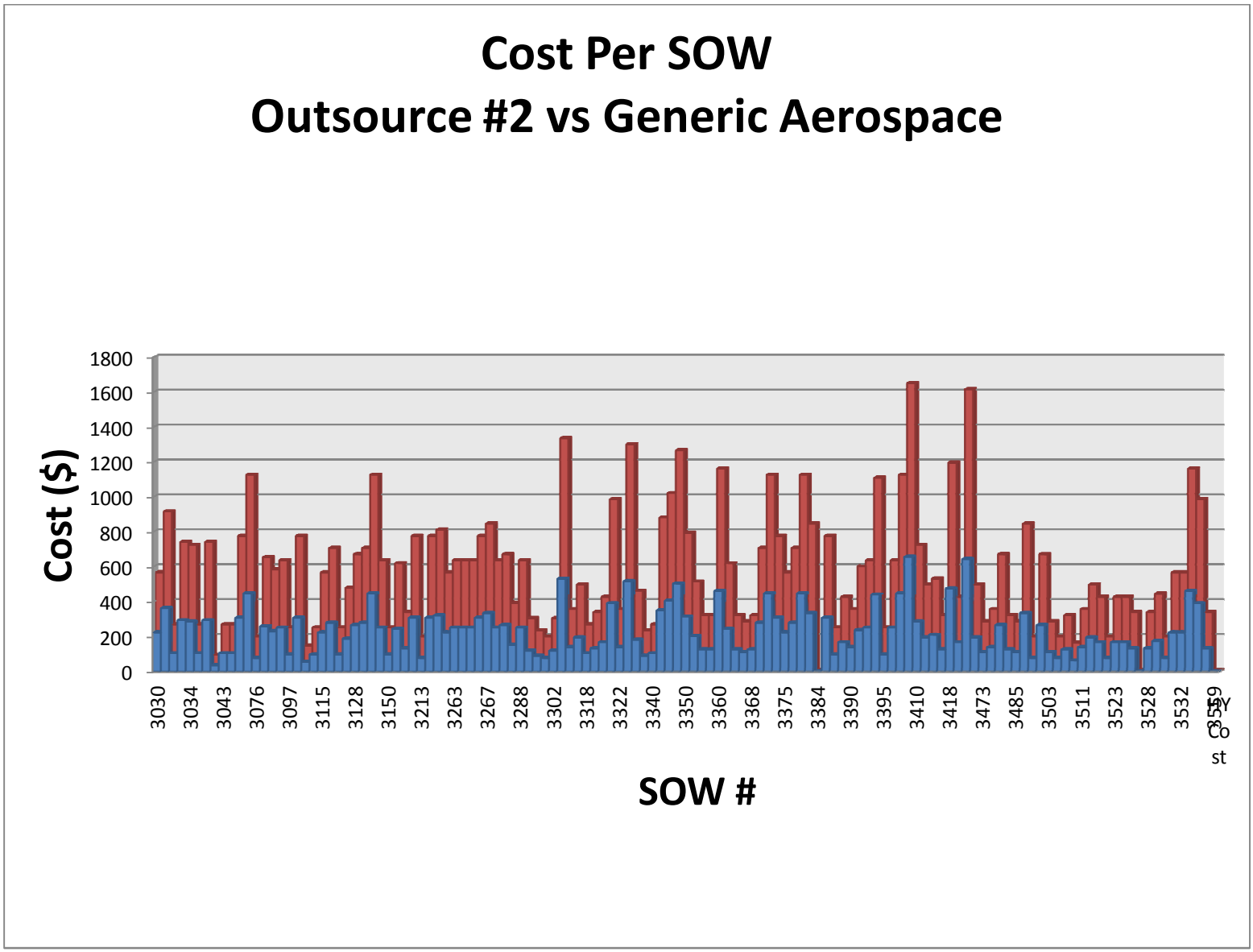
C. Outsource #2 Actual vs. Estimated



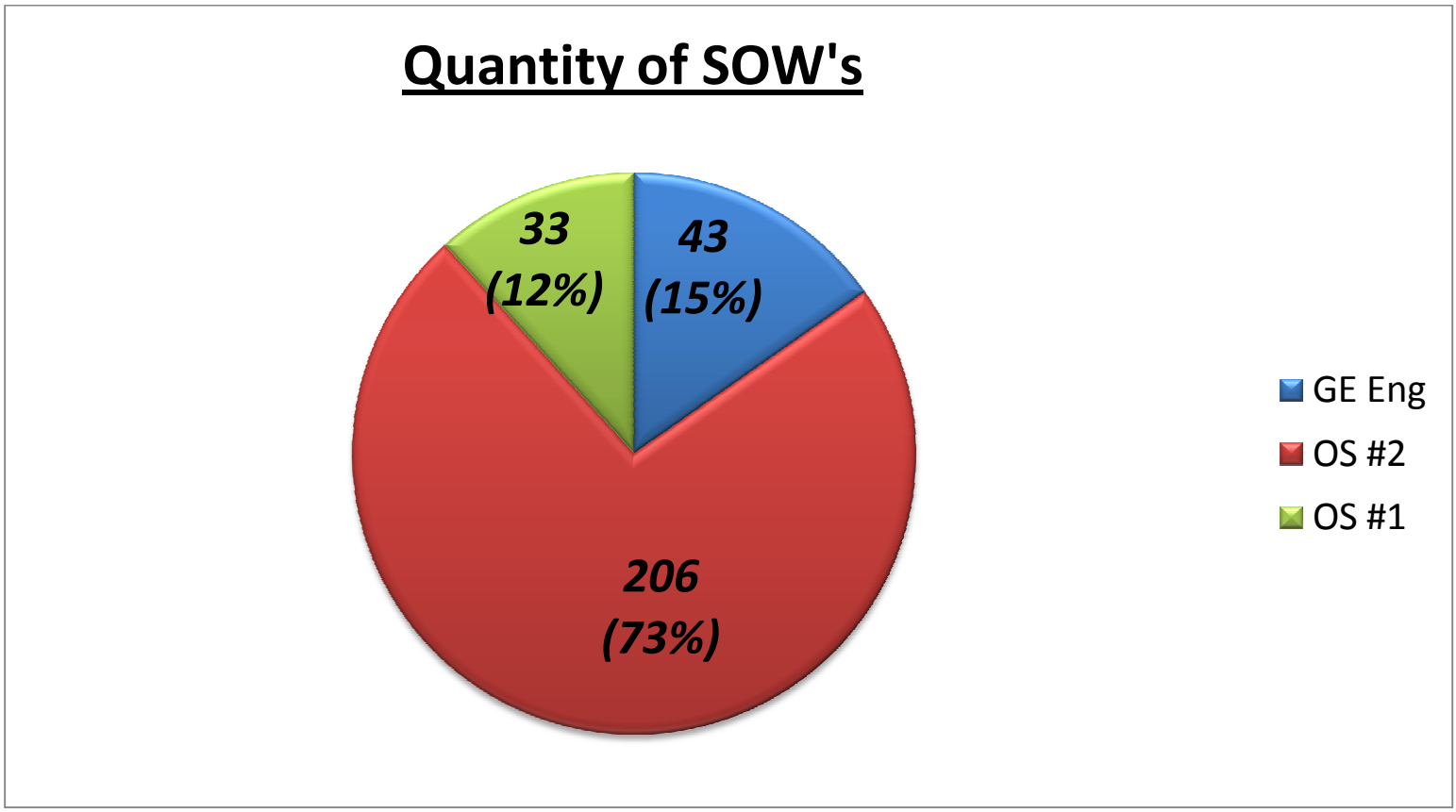
D. Cost per SOW- Outsource #1 vs. Generic Aerospace

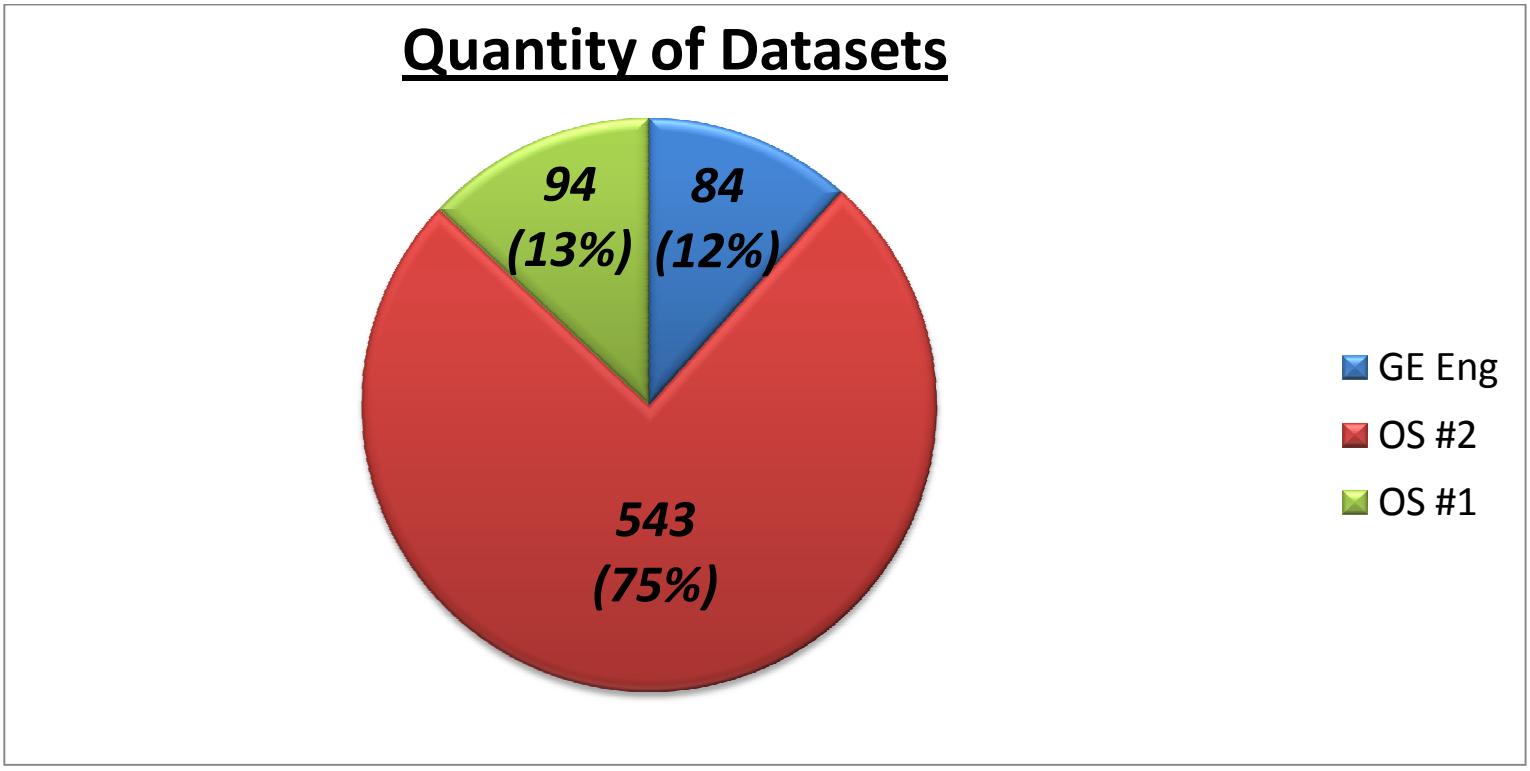


E. Cost per SOW- Outsource #2 vs. Generic Aerospace

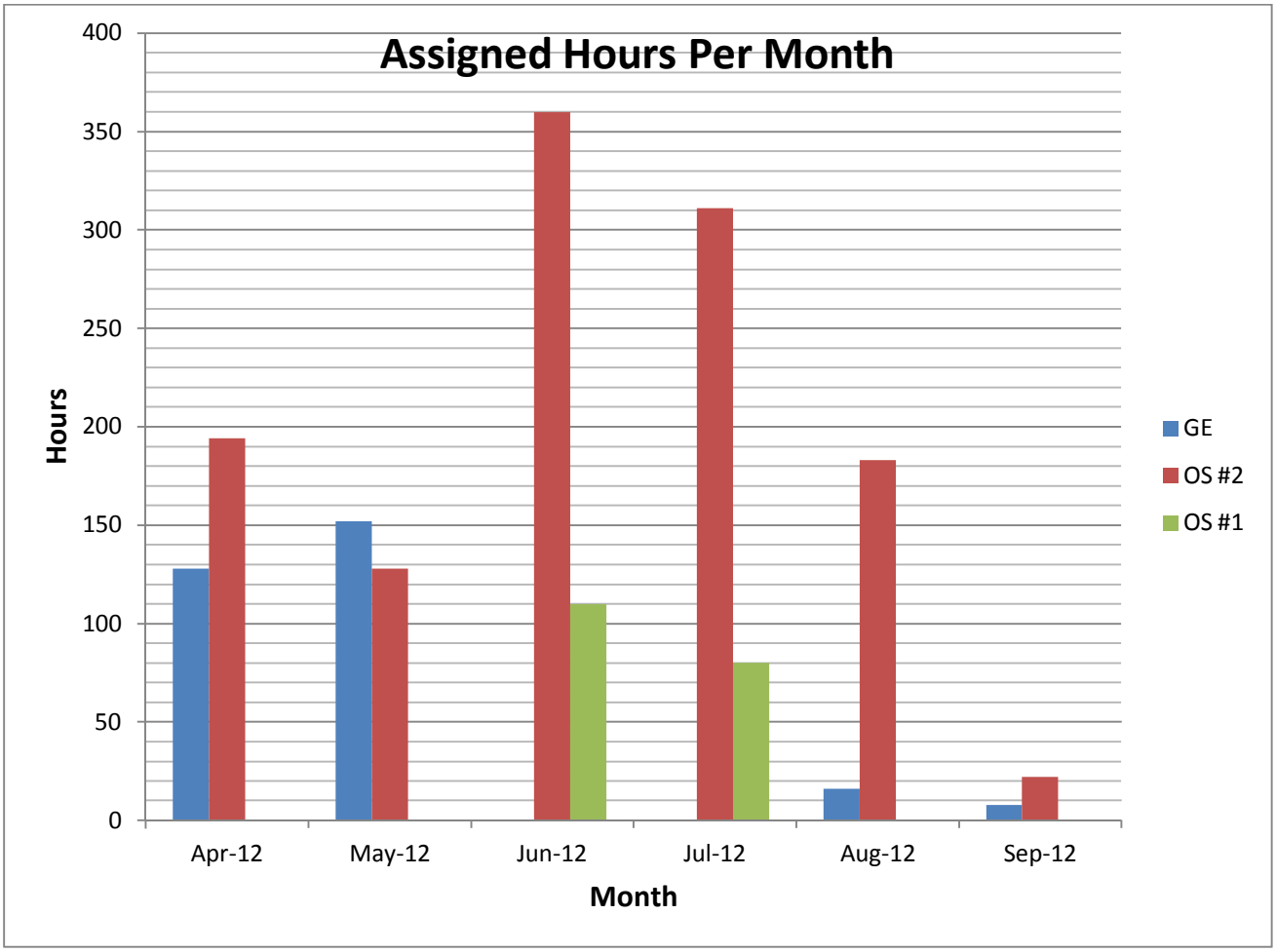


F. **Work Distribution- Generic Aerospace vs. Outsource #1 & #2**

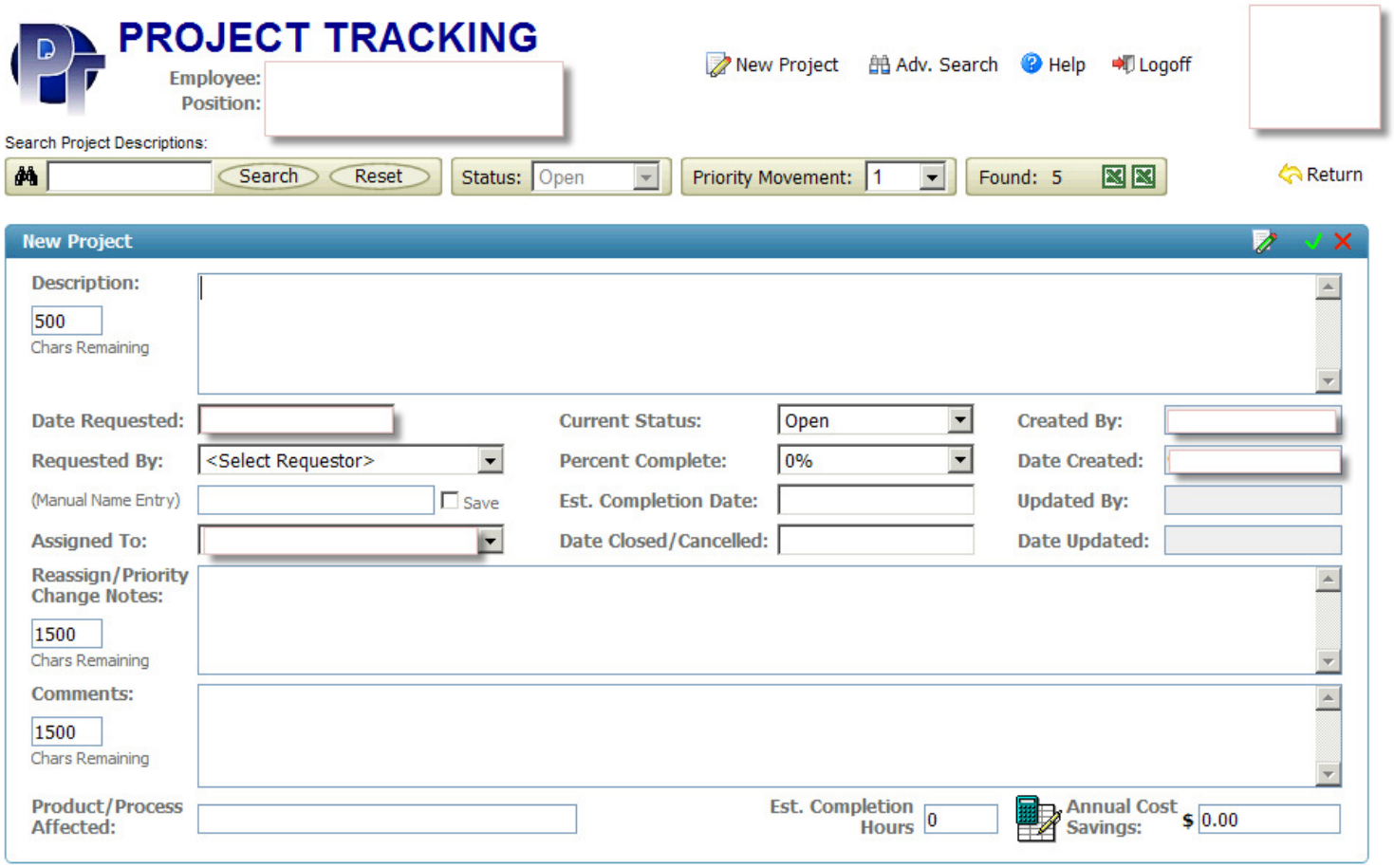




G. Assigned Hours Per Month



H. Request for Work Database



I. Drawing Document Check List

Designer Check List

Use X, √ or N/A

DCN	Drawings & Revisions	Assemblies
____ Is Product Listed?	____ Is Revision Letter Correct?	____ Item Quantities Correct
____ Correct Class?	____ Is Revision Letter Correct On Additional Pages?	____ Are Component Part Numbers Correct?
____ Does DCR Number Match DCR?	____ Does Revision Notice Number Match DCN	____ Are Component Titles Correct?
____ Requested By: Name & Date?	____ Does Drawing Title Follow EDS Naming Conventions?	____ Is Component Material Correct?
____ Written By: Name & Date?	____ Is Part Number Correct?	____ Are Components In JDE?
____ Subject Of Change Listed?	____ Does Weight Match DCR?	____ Are Items Ballooned On Drawing?
____ Reason For Change Listed?	____ Is Scale Listed?	____ Are Balloons To Correct Item Numbers?
____ Is It Customer Controlled? Customer Name?	____ Is Drawing Per EDS Standards?	____ Do Drawing Numbers Match Item Numbers In BOM?
____ Does Document Record Number Match Drawing Number?	____ All dimension reviewed?	____ Do Item Numbers In Notes Match Item Numbers In BOM?
____ Do Revision Levels Match Drawing? All Sheets?	____ Note information correct?	
____ Does Document Title Match Drawing Title?	____ Title Block information correct?	
____ Attention Notes listed?	____ Are There Other DCRs For The Part?	
____ Are New and Old Rev Correct	____ Have All DCR Requirements Been Met?	
____ Is NOC Referenced	____ If A PC Bare Board Is Involved, Is Gerber Current?	
	____ Is Model Referenced In Notes Correct (Rev)?	
	____ Are Notes In Standard Form?	
	____ Do Flags Mark Correct Areas?	
	____ Are The Current Standards / Specifications Being Referenced?	
	____ Any Misspellings Or Grammar Errors?	
	____ Have Changes Been Made Per Redline(s) and NOC?	
	____ Have All Changes Been Added To DCN?	

J. Product Support Document Check List

DOCUMENT CHECK LIST

Check Item	TPC	TPW	Eng	Comment
Print DCR & Compare to Document				
HEADER/FOOTER (GENERAL)				
Correct base part number appears in the header.				
Correct ATA/CMM number appears in the footer.				
Correct publication date appears in the footer.				
Correct revision appears in the footer.				
SECTION ERROR TOTAL **Enter data on this line**	**# of pages in Section**	**# of pages in Section with errors**	**=**	
FRONT MATTER (GENERAL)				
Title page should reflect the correct B/E Logo (B/W).				
Title page should reflect the correct CMM title.				
Title page should reflect the correct part numbers. The part numbers should match the top-level engineering drawings in the IPL.				
Original Issue date appears.				
Title page should reflect the correct B/E Aerospace CAGE code: OSP – 16827 or BMP – 63367				
Title page should reflect the correct US Export regulation information.				
Alert Page (A-1) should reflect the correct product line – OSP or BMP.				
Alert Page (A-1) should reflect the correct copyright year.				
Alert Page (A-1) should reflect the correct CMM # and Page in the footer.				
Highlight Page(s) should match the change page(s) in the manual. Applicable for document revisions only.				
ROR should reflect all revision numbers and correct issue dates.				
RTR should reflect all applicable temporary revisions incorporated.				
SBL should show all applicable service bulletins incorporated (check IRIS).				
SIL should show all applicable service information letters incorporated (check IRIS).				
LEP should reflect the page # in the manual. Verify every page.				
TOC should reflect all sections. If some sections are not applicable to the manual, that should be indicated by "Not Applicable" in the page number section.				
SECTION ERROR TOTAL **Enter data on this line**	**# of pages in Section**	**# of pages in Section with errors**	**=**	

Page 1 of 6 FORM: WI–Tech Pub Doc.001 (Rev. B) DCN TC11-9375

DOCUMENT CHECK LIST

Check Item	TPC	TPW	Eng	Comment
INTRODUCTION (GENERAL)				
Table Abbreviations are in alphabetic order?				
SECTION ERROR TOTAL **Enter data on this line**	**# of pages in Section**	**# of pages in Section with errors**	**=**	
DESCRIPTION AND OPERATION (1 THRU 999)				
Text/content should be as per the reference manual (if provided).				
Check conversions/Warnings/Caution/Notes				
Check operating values in the Leading Particular table. These should match top level assy drawings.				
Check numeric sequence .				
SECTION ERROR TOTAL **Enter data on this line**	**# of pages in Section**	**# of pages in Section with errors**	**=**	
TESTING AND FAULT ISOLATION (1001 THRU 1999)				
Text/content should be as per the reference manual (if provided).				
Check references.				
Check conversions/Warnings/Cautions/Notes.				
Check numeric sequence.				
Check Troubleshooting Method.				
Check Testing Method against ATP.				
SECTION ERROR TOTAL **Enter data on this line**	**# of pages in Section**	**# of pages in Section with errors**	**=**	
SCHEMATICS AND WIRING (2001 THRU 2999)				
Text/content and electrical installation should be as per the electrical part number drawing.				
Check numeric sequence.				
SECTION ERROR TOTAL **Enter data on this line**	**# of pages in Section**	**# of pages in Section with errors**	**=**	

DOCUMENT CHECK LIST

Check Item	TPC	TPW	Eng	Comment
DISASSEMBLY (3001 THRU 3999)				
Text/content should reflect as per the reference manual (if provided).				
Reference to IPL Figures are correct.				
Item numbers should match the IPL illustration item number exactly.				
Check numeric sequence.				
Item numbers and quantities should match the IPL illustration item number and quantities exactly.				
Section should mirror the Assembly Section.				
SECTION ERROR TOTAL **Enter data on this line**	**# of pages in Section**	**# of pages in Section with errors**	=	
CLEANING (4001 THRU 4999)				
Text/content should reflect as per the reference manual (if provided).				
Check all cleaning agents are listed in the Table 4001 and also are in the procedures.				
Check numeric sequence.				
SECTION ERROR TOTAL **Enter data on this line**	**# of pages in Section**	**# of pages in Section with errors**	=	
INSPECTION/CHECK (5001 THRU 5999)				
Text/content should reflect as per the reference manual (if provided).				
Check numeric sequences.				
Check all values mentioned in the Table are matched in the engineering data.				
Text/content should reflect as per Engineering data.				
SECTION ERROR TOTAL **Enter data on this line**	**# of pages in Section**	**# of pages in Section with errors**	=	
REPAIR (6001 THRU 6999)				
Text/content should reflect as per the reference manual (if provided).				
Check numeric sequences.				
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DOCUMENT CHECK LIST

Check Item	TPC	TPW	Eng	Comment
ASSEMBLY (7001 THRU 7999)				
Text/content should reflect as per the reference manual (if provided).				
Reference to IPL Figures are correct.				
Check numeric sequence.				
Item numbers should match the IPL illustration item number exactly.				
Procedure quantities reflect the number of items shown in the illustration.				
Section should mirror the Disassembly Section.				
Check torque values.				
SECTION ERROR TOTAL **Enter data on this line**	**# of pages in Section**	**# of pages in Section with errors**	=	
SPECIAL TOOLS, FIXTURES AND EQUIPMENT (9001 THRU 9999)				
Text/content should reflect as per the reference manual (if provided).				
Check all tools, equipment, materials, consumables which are in the manual are listed in Table 9001.				
Check numeric sequence.				
SECTION ERROR TOTAL **Enter data on this line**	**# of pages in Section**	**# of pages in Section with errors**	=	
SPECIAL PROCEDURES (11001 THRU 11999)				
Text/content should reflect as per the reference manual (if provided).				
Check numeric sequence.				
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REMOVAL (12001 THRU 12999)				
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DOCUMENT CHECK LIST

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INSTALLATION (3001 THRU 13999)				
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SERVICING (1400 THRU 14999)				
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SECTION ERROR TOTAL **Enter data on this line**	**# of pages in Section**	**# of pages in Section with errors**	=	
STORAGE (15001 THRU 15999)				
Text/content should reflect as per the reference manual (if provided).				
Check numeric sequence.				
SECTION ERROR TOTAL **Enter data on this line**	**# of pages in Section**	**# of pages in Section with errors**	=	
REWORK (16001 THRU 16999)				
Text/content should reflect as per the reference manual (if provided).				
Check numeric sequence.				
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ILLUSTRATED PARTS LIST (10001 THRU 10999)				
Text/content should reflect as per the reference manual (if provided).				
Check all vendor CAGE Code information is listed in Table 10001.				
Check all part number and correct effectivity codes are listed in Table 10002 (if applicable).				
Check Alpha/Numeric Index for any missing quantities.				
Check Alpha/Numeric Index Part number column should be in sequence order.				
Check "ITEM NOT ILLUSTRATED": information is mentioned at the end of the Table.				
Each parts list starts on an odd numbered page.				
Section continued on following page				

DOCUMENT CHECK LIST

Check Item	TPC	TPW	Eng	Comment
ILLUSTRATED PARTS LIST (10001 THRU 10999) continued				
Check top level assembly part numbers match the Title page.				
Nomenclature should match the prints and/or Engineering BOM.				
Each figure illustration starts on an even numbered page.				
Item-by-item check of parts list vs. illustration is consistent.				
Items not illustrated have a dash (-) before the item number.				
SECTION ERROR TOTAL **Enter data on this line**	**# of pages in Section**	**# of pages in Section with errors**	**=**	
GENERAL DOCUMENT CHECKS				
Each new section starts on an odd numbered page and ends on an even numbered page.				
References to sections are all caps (ex: Refer to Table 6001 in REPAIR).				
Table and Figure numbers /titles are present and set correctly.				
Change bars (or R) are present for all revised text.				
Spelling is correct.				
Grammar is correct (verb tense subject-verb agreement).				
Correct punctuation/capitalization.				
Correct use of articles/pronouns.				
SECTION ERROR TOTAL **Enter data on this line**	**# of pages in Section**	**# of pages in Section with errors**	**=**	

K. Offshore Tracking Database

Open	Type Of Work - Eng	Type Of Work - Tech Pubs	Program	DCR #	SOW #	Priority	Status	%	Assigned To	# of Data:	ESTD Hrs	Actual Hrs	Start Date	Due Date	Completed
Open	2D Drawing Change		LCC	9411	3526	(2) Normal	In Progress	0%		1	6		8/24/2012	8/31/2012	8/30/2012
Open	3D From 2D		Legacy	NA	3015	(2) Normal	In Progress	0%		52	312		4/9/2012	6/15/2012	
Open	2D Drawing Change		LCC	14251	3472	(2) Normal	In Progress	0%		1	8	7	8/9/2012	8/16/2012	8/16/2012
Open	2D Drawing Change		LCC	14229	3474	(2) Normal	In Progress	0%		1	4	5	8/9/2012	8/16/2012	8/16/2012
Open	2D Drawing Change		LCC	14284	3483	(2) Normal	In Progress	0%		3	12	9.5	8/13/2012	8/20/2012	8/16/2012
Open	2D Drawing Change		LCC	9720	3484	(2) Normal	In Progress	0%		1	4	4.5	8/13/2012	8/20/2012	8/16/2012
Open	2D Drawing Change		LCC	13849	3485	(2) Normal	In Progress	0%		1	4	4	8/13/2012	8/16/2012	8/16/2012
Open	2D Drawing Change		LCC	8534	3486	(2) Normal	In Progress	0%		1	12	12	8/13/2012	8/27/2012	8/27/2012
Open	2D Drawing Change		LCC	14295		(2) Normal	Not Started	0%					8/14/2012		
Open	2D Drawing Change		LCC	14295	3493	(2) Normal	In Progress	0%		1	2	2.75	8/14/2012	8/20/2012	8/16/2012
Open	2D Drawing Change		LCC	8382	3494	(2) Normal	In Progress	0%		3	9	9.5	8/15/2012	8/23/2012	8/17/2012
Open	2D Drawing Change		LCC	14344	3503	(2) Normal	In Progress	0%		1	4	4	8/20/2012	8/27/2012	8/22/2012
Open	Tech Pubs Test 1		B787			(2) Normal	Not Started	0%					8/20/2012		
Open	2D Drawing Change		LCC	11274	3508	(2) Normal	In Progress	0%		1	2	2.75	8/20/2012	9/5/2012	8/30/2012
Open	2D Drawing Change		LCC	13389	3528	(2) Normal	In Progress	0%		1	6	4.75	8/27/2012	8/31/2012	8/28/2012
Open	2D Drawing Change		LCC	13478	3529	(2) Normal	In Progress	0%		2	6	6.25	8/27/2012	8/31/2012	8/30/2012
Open	2D Drawing Change		LCC	13740	3530	(2) Normal	In Progress	0%		1	2	2.75	8/27/2012	8/31/2012	8/28/2012
Open	2D Drawing Change		LCC	13835	3531	(2) Normal	In Progress	0%		1	6	8	8/27/2012	8/31/2012	8/30/2012
Open	2D Drawing Change		LCC	11483	3532	(2) Normal	In Progress	0%		1	4	8	8/27/2012	8/31/2012	8/30/2012
Open	2D Drawing Change		LCC	11295	3547	(2) Normal	In Progress	0%		5	16	16.5	8/30/2012	9/5/2012	9/7/2012
Open	2D Drawing Change		LCC	14249	3548	(2) Normal	In Progress	0%		2	6	14	8/30/2012	9/7/2012	9/4/2012
Open	2D Drawing Change		LCC	13978	3550	(2) Normal	In Progress	0%		1	4	4.75	8/30/2012	9/5/2012	8/31/2012
Open			otes2			(2) Normal	Not Started	0%					8/31/2012		
Open	2D Drawing Change		LCC	10913	3559	(2) Normal	In Progress	0%		3	10		9/5/2012	9/12/2012	9/7/2012
Open	2D Drawing Change		787 Oxygen	14491	N/A	(2) Normal	In Progress	0%		7	54		9/6/2012	9/11/2012	9/11/2012
Open	2D Drawing Change		LCC	14180	3574	(2) Normal	In Progress	0%		1	4		9/11/2012	9/18/2012	9/12/2012
Open	2D Drawing Change		LCC	14507	3575	(2) Normal	In Progress	0%		2	6		9/11/2012	9/18/2012	9/17/2012
Open	2D Drawing Change		LCC	14185	3577	(2) Normal	In Progress	0%		1	2		9/11/2012	9/18/2012	9/12/2012
Open	2D Drawing Change		LCC	10993	N/A	(2) Normal	In Progress	0%		1	2	1	9/11/2012	9/12/2012	9/11/2012
Open	2D Drawing Change		Sustaining	14538	3584	(2) Normal	In Progress	0%		1	4		9/12/2012	9/18/2012	9/13/2012