Requirements-Based Methodology for Determining Age Inventory Levels

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REQUIREMENTS-BASED METHODOLOGY FOR DETERMINING AGE INVENTORY LEVELS

THESIS

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James A. MacKenna

Table of Contents

Page

List of Figures

List of Tables

Page

AFIT/GLM/ENS/01M-15

Abstract

The purpose of this research was to illuminate crucial areas in analyzing AGE needs on an operational flightline and assist in determination of AGE inventory levels. Further refinements could result in more objective and accurate assessments of actual flightline AGE needs and associated risks involved with reduction of AGE inventory levels.

The research in this thesis consists of a discrete event simulation to determine desired AGE inventory level through an analysis of aircraft launches and wait time for AGE support by varying AGE (mean time between failure) MTBF and AGE inventory. Stochastic inputs for aircraft failures, AGE delivery times, and AGE MTBF were used. The scope of this effort was primarily concerned with an appropriate methodology to determine actual AGE requirements through analysis of consumption patterns and risk to reach a desired service level. The result of this effort was a defined methodological approach in determination of AGE levels that could be applied across aircraft and AGE type.

REQUIREMENTS-BASED METHODOLOGY FOR DETERMINING AGE INVENTORY LEVELS

I. Introduction

Problem

Aerospace Ground Equipment (AGE) is used to service aircraft while the aircraft is on the ground. It is the aircraft maintainer's job to ensure aircraft are serviced and repaired expediently thereby maintaining high percentages of their aircraft fleet in mission ready status. The desire to have these high aircraft mission capable rates has resulted in keeping high inventory levels of everything imaginable necessary to sustain the aircraft. No maintainer wants to see aircraft mission losses due to a lack of functional AGE. Thus, to mitigate the impact of potentially unreliable AGE, excess AGE inventory is the norm. This excess inventory phenomena is not limited to AGE but includes tools, parts, and supplies. In other words, over the years, the Air Force fielded increasing amounts of AGE, "just in case." Since some AGE serviced by the AGE maintenance shop have very little actual operating time between service intervals some question whether the amount of AGE in the field is excessive.

The level of AGE (or any support equipment) at a given location is determined by that location's table of allowance authorization. Currently, Air Mobility Command (AMC), queries subject matter experts (SME's) to determine the table of allowance authorizations for AGE. This is done base-by-base, with

Unit Type Codes (UTC's) and mission requirements of each base determining the final total allowance authorization. As the Air Force enters the 21st century, the Air Force must reduce instances of excess assets in the most effective manner possible.

With AGE, this is most effectively addressed on two dependent issues: the number of AGE units required and the reliability of the AGE units. By closely examining what is actually required to support aircraft, the Air Force can identify excesses and shortfalls to provide maximum utility from limited resources. Considering the reliability of the AGE units is a major input into the number of units required due to potential reliability problems with either newly deployed or aging systems. Effective utilization of limited resources supports the Joint Vision 2020 concept of seamless integration of support requirements through, "focused logistics." (Joint Vision 2020, 2000)

AMC Interest

AMC reviewed the paper by O'Fearna, Hill, and Miller (2000) based on the thesis entitled, Reduction of the Aircraft Ground Equipment Footprint of an Air Expeditionary Force, by Captain Frank C. O'Fearna, and found the force sizing methodology attractive. O'Fearna sought to define the amount of AGE needed by a deploying fighter expeditionary force reducing AGE levels without impacting the mission. His approach was AGE-utilization based. Using a model to track utilization of particular AGE units as dictated by a squadron flying schedule coupled with aircraft component failure and repair data. Under-utilized equipment became candidates for inventory reduction, deployment delay or even elimination from the deployment plan.

AMC would like to use a similar approach and apply an analysis of need to AMC AGE levels, with the possibility of long-term AGE leveling strategies. AMC is purchasing a new nitrogen system, the Self Generating Nitrogen Servicing Cart (SGNSC), and would like to do a demonstration project in AGE leveling, assessing utilization of SGNSC as the first potential application of a methodology. The current method AMC uses to determine AGE levels appear to overstate need, and the purchase of a new nitrogen system for use throughout the Air Force, with AMC as the lead command, is an excellent opportunity to compare current practice with a more analytical approach to determining AGE levels. The intent of course is to reduce AGE levels without impacting aircraft mission capable rates.

Proposal

A stochastic discrete-event queuing simulation used to determine the Basis Of Issue (BOI) may provide a more accurate starting point for determining AGE authorizations. A quantitative methodology, initially applied to SGNSC, and eventually extended to other AGE inventory, may allow AMC to more effectively assess the need and utilization of AGE. This assessment should provide opportunities for cost savings through AGE reduction along with a risk assessment associated with the proposed reduction.

Scope of Research

The primary purpose of this research is to refine and demonstrate a methodology for assessing AGE utilization in a given scenario while noting any impacts on mission capability. The goal is to use this quantitative methodology to size an AGE fleet to meet aircraft demand at a base of study, and perform sensitivity analysis on any maintenance delay if the aircraft must wait for AGE assets.

In an effort to analyze the impact of SGNSC, and limit confounding effects of possibly redundant variables, variables such as maintenance, fuel, etc, will be modeled as unconstrained resources. AGE will be delayed for 10 minutes after it is identified to allow for delivery. Statistics will be gathered on AGE utilization to show usage, percentage of cancelled missions (PCM) to show the net effect of different AGE levels, and the actual number of cancelled missions. It is anticipated that AGE utilization will be very low due to high service levels. Carrico and Clark found this to be true in their research although their results were based on using levels of AGE as assigned by the table of allowances, and sensitivity analysis of the effect of different AGE levels was only conducted for the Modular Aircraft Support System (MASS). (Carrico and Clark, 1996:15, 18-20) The focus of the current study is to determine the actual amount of AGE necessary to meet requirements, regardless of the table of allowance values, such as those used in Carrico and Clark's study. They also used PCM in their study as a measure of mission effectiveness. They used a static measure. A delay of over 30 minutes would result in a cancelled mission. (Carrico, 1996:16)

This is not an unreasonable assumption, since current AMC guidance is to cancel a mission if the aircraft exceeds the launch window by 15 minutes. An attempt will be made to use actual cancelled missions in the current study.

Issues/Needs/Limitations

SGNCS reliability/(Mean Time Between Failure) MTBF rates are unknown. Engineering data from the contractor and any reliability testing will be used as a baseline for failure rates. According to Carrico and Clark, sensitivity analysis of reliability figures did not have an influence of practical significance on AGE's impact to Flight Sortie Effectiveness. (Carrico and Clark, 1996: 23-25) Similar results are expected for this study.

Constraints imposed by the airfield, such as the maximum number of serviced aircraft on the ground at one time limit the potential aircraft population pool that require SGNSC support. Historical throughput data for Travis AFB will be used to determine the population of aircraft requesting SGNSC support.

GO81 is the aircraft maintenance database for heavy aircraft which are the focus of this study. GO81 has limitations thus using its data for this study will impact the accuracy of our analytical model. Where GO81 data is unavailable, SME interviews will be used to obtain the necessary data. The primary data required is that data suggesting any maintenance-based nitrogen needs.

One of two issues not addressed in this research is the dynamic redistribution of CONUS SGNCS. AMC aircraft could bring their own Nitrogen support to a deployment base. Since AMC aircraft would likely fly empty to the base, they could carry a SGNSC with them for the deployment activity, and then take it home when they are done. This would require coordination on the return trip, but has potential for savings in acquisition and life cycle costs. However, the command, control, and funding issues are far outside the scope of this effort, and this will not be explored. However, AGE is not such small change anymore. The initial SGNSC contract is a $20 million effort with an estimated 570 units at $35k each, not including operations and maintenance costs. (DefenseLINK News, 1998) While it does not compare with the B-2 program, it does carry potential for cost reductions, and is worth examining. Further, these are only procurement costs, and do not include other costs such as reliability, maintainability, and mobility/deployment.

This thesis also does not examine the impact of other AGE on aircraft availability at this point. This thesis only addresses the impact of SGNSC through comparison of distributions of different variables against each other through a queuing simulation to determine range of utilization and size SGNCS inventory to accommodate mission requirements.

II. Literature Review

Aerospace Ground Equipment (AGE)

AGE is used for the servicing and maintenance of aircraft while the aircraft are on the ground. AGE is a relatively inexpensive way to maintain aircraft compared to using systems onboard the aircraft. AGE may be readily replaced without impacting the aircraft mission capability. Systems onboard the aircraft would need servicing which would impact aircraft availability. AGE is a necessary part of the flightline environment and some form of AGE is almost always used whenever performing aircraft maintenance.

AGE delivery is also an issue. The delivery of AGE, if it is available, is dependent on the AGE driver and the delivery vehicle. For purposes of the current research, AGE drivers are assumed to be on duty when demanded and that an AGE delivery vehicle is available when required. Delays may be modeled to account for driving time around the flightline.

Self Generating Nitrogen Servicing Cart (SGNSC)

SGNSC is a self-contained powered AGE unit that uses outside air to refill storage cylinders filled with nitrogen. The cart takes outside air, builds pressure and filters nitrogen through a membrane into the storage cylinder. The nitrogen is retained in the cylinder until discharged. The system is entirely self-contained and does not require refilling from outside sources, saving time and money, while increasing safety.

Previous AGE Research

Carrico and Clark– IMDE

Carrico and Clark studied the Multi-function Aerospace Support System (MASS) using the Integrated Model Development Environment (IMDE). Carrico created a model to study the effects of varying levels of AGE, AGE travel time, and flying schedules on the utilization and effectiveness of MASS, and MASS's impact on aircraft availability. Carrico and Clark measured the impact of AGE by examining changes to the percentage of cancelled missions. (Carrico and Clark, 1996:16)

The results from Carrico and Clark's study supported the position that combined AGE units could supplant current AGE without affecting unit mission effectiveness. However, he made the observation that a compressed flying schedule, with several missions and small intervals between launch times, could dramatically increase abort rates. (Carrico and Clark, 1996:35) By varying numbers of MASS units, Carrico and Clark observed that the sharp increase in the abort rate under the compressed schedule was primarily due to the defined aircraft repair times, not the availability or non-availability of support equipment. (Carrico and Clark, 1996:35)

Carrico and Clark also found that the time needed to physically move AGE from one position to another had a significant impact on mission effectiveness. (Carrico and Clark, 1996:35) However, AGE can be called for by the maintenance supervisor in advance of maintenance and thus negate the effect of travel time. This significantly reduces the effects of travel time predicted by the simulation with the potential exception of maintenance work that occurs with discovery of a discrepancy during a pre-flight check, commonly called a, "red streak." Red streaks are a minor part of overall maintenance tasks accomplished in an organization. Carrico and Clark did not address "red streaks" in his study. His interviews with maintenance personnel indicated that waits of 15 – 20 minutes were not uncommon. He thus delayed all AGE for all maintenance actions, effectively yielding a worst case scenario. (Carrico and Clark, 1996:15)

Interviews with personnel at Travis revealed that delivery times were tracked, and AGE was delivered in less than 10 minutes 80 percent of the time and in less than 20 minutes 99% of the time. (Labadie, 2000) This delivery distribution was the AGE delivery delay modeled in LCOM.

Havlicek

Lieutenant Jeffrey Havlicek modified Carrico and Clark's model to examine the effect of consolidating AGE in response to the development of the MASS and compare the MASS unit to the Combined Generator Air Conditioner (CGAC), legacy AGE, and a combination of MASS and CGAC. He modeled a single F-16 squadron over a 30 day deployment and manipulated MTBF/mean time to repair (MTTR) of the AGE units and travel time. He measured the percentage of cancelled missions and the number of requests in the queue, but did not measure the time spent in the queue.

Havlicek performed cost analysis on his results and concluded that CGAC was the least expensive option up to 27 deployments, at which point the MASS option became less expensive. (Havlicek, 1997:85) The legacy AGE option did not compete effectively at any point. The reason the CGAC was less expensive for the first 27 missions was the acquisition cost of the unit. After 27 deployments the MASS unit made up for the initial higher acquisition costs in Havlicek's model. Havlicek used fixed quantities of AGE for his study due to his manipulation of other variables. The study was primarily a cost analysis of the different AGE configurations available based on a set requirement. He does not question the requirement itself, but that was not the focus of the study.

O'Fearna

Captain Frank O'Fearna created a queuing simulation in Awesim to address AGE utilization in a deployment of fighter aircraft. He created enormous databases of information on AGE-supported maintenance performed on F-15 aircraft based on extensive interviewing with field experts. This is an extremely time-intensive task and is not suitable to the desired extensibility of this thesis. However, the basic approach and model used by O'Fearna in his thesis was a template for the current thesis. O'Fearna used Work Unit Codes (WUCs) to drive maintenance actions. WUCs identify systems in an aircraft at various system/subsystem levels. Actual failure data in maintenance databases are theoretically keyed to WUCs. This means a stochastic model may model failures at a given subsystem level and the WUC will indicate the failure and the maintenance actions required to rectify the failure. O'Fearna's databases were based on WUCs. His model captured failures at a subsystem level and a matrix of maintenance actions and AGE requirements was employed to model the resulting maintenance process.

O'Fearna tried to determine the actual amounts of AGE required to support a deployment of an F-15 fighter squadron using a simulation model of an Air Expeditionary Force. Previous analysis of AGE levels consisted of justification of current allowance tables vice leveling AGE for maximum utilization while still meeting mission requirements. O'Fearna's goal was to reduce the logistics "tail," the support equipment required to keep aircraft mission ready. This is what initially lured AMC into pursuing a study on requirements based AGE inventory levels. While O'Fearna's study presented preliminary results, it aptly illustrated the potential gains of a more analytical approach to AGE inventory level determination.

Festejo

Festejo extended O'Fearna's model to specifically address MASS substitutability of legacy AGE and MASS reliability. By modeling failures in the MASS cart, Festego examined the impact and sensitivity of MASS reliability on the FSE of an AEF. Festejo found that the future MASS would have to be extremely unreliable, or require an inordinate amount of repair time, before FSE would be effected. Even then, just-in-time delivery of replacement MASS units could compensate to maintain mission effectiveness levels. (Festejo, 2000)

Logistics Composite Model (LCOM)

The Logistics Composite Model (LCOM) is a discrete event queuing simulation. It was developed by Air Force Logistics Command in the 1960's with the Rand Corporation to analyze maintenance processes. (L-COM Final Report,

1973) In 1970, Tactical Air Command used LCOM to determine maintenance manpower requirements for a squadron of F-4E aircraft. The end result, according to the final report, was that LCOM gave, "proof positive" through the actual operational units flying a schedule developed through LCOM, that LCOM was a valid model for determination of manpower requirements. (L-COM Final Report, 1973, 1-6) As LCOM has matured, systematic changes have been made to the model so that LCOM remains a valid, adaptable, well-written program. In 1992, ASC conducted a study for the F-15E Eagle Century plus Radar Program. They combined this study with a validation effort for LCOM. The study compared LCOM predictions with actual results. As can be readily seen from Table 1, the LCOM model conformed very closely to actual sortie rates and APG-70 actions, with a close to or less than 1% difference between the model and the real world.

Table 1: Desert Storm (1/16-2/28 1990) vs. modeled statistics (JSF JIRD III Accreditation Report, 4-17)

	Actual	Model	
Sorties Flown	2185	2209	(within 1.1%)
Flying Hours	7360	7379.6	(within 0.2%)
APG-70 LRU Pulls	224	226.6	(within 1.1%)
APG-70 CNDs	115+	118.7	(within 3%)

LCOM results were also compared to Luke AFB F-15E operations for a 56 day period with the results presented in Table 2. LCOM results were again very close to the real world.

Table 2: Luke AFB vs. Modeled Statistics (JSF JIRD III Accreditation Report, 4-17)

	Actual	Model
Sorties Flown	1040-1120	1111.2
Flying Hours	1640	1633.2
APG-70 LRU Pulls	105	105.1

LCOM has been selected by numerous System Program Offices (SPOs), including but not limited to the B-2, F-22, JSF, and C-17 SPOs for use in determining supportability requirements. (Wallace, 18 Dec 2000) LCOM was formally accredited by the JSF SPO as a satisfactory supportability model to analyze Sortie Generation Rate, Manpower, Support Equipment/Facilities, Spares, Prognostics/Health Management, Cannibalization, and Resource Constraints. (Draft JSF JIRD III Accreditation Report, 4-7, 4-8)

The verification of LCOM by the JSF IRD and the use of LCOM by numerous current and next generation aircraft SPOs, as well as the studies comparing LCOM output to real world results, speaks to the acceptability of LCOM as a model for the study of AGE and the support it provides to the flightline.

Current AGE BOI and Utilization

Interviews with HQ AMC AGE personnel stated AGE BOI is currently determined by SME's with field experience. The SPO for the weapon system meets with the command headquarters AGE representatives and the AGE management agency from Robins AFB (WRALC/LE). They review AGE usage at the bases where the weapon system is maintained. They then negotiate the AGE table of allowances based on estimated future usage.

Currently, AGE utilization is very low. Metered hours per cart point to an overabundance of AGE, possibly even an overabundance for surge situations which is a worst-case scenario for flightline operations and aircraft maintenance.

To measure the impact of AGE on the mission, O'Fearna used Flight Sortie Effectiveness (FSE) as the measure for sensitivity analysis of AGE availability. The issue with FSE, as it is commonly used, is it is post-mission, and includes factors such as weather, pilots, navigation, and other variables hiding the impact of AGE. O'Fearna did not use FSE in the traditional sense, as he excluded other variables such as weather to prevent confounding effects on his analysis. However, FSE lends confusion when discussing the issue with those in the field, as they interpret FSE to include all variables, not just AGE support.

III. Methodology

General Approach

LCOM, a simulation model, with stochastic inputs from several sources, will drive demand for SGNSC and determine capacity and utilization. Standard flight schedules will determine the potential population of aircraft that may require SGNSC support. Work Unit Codes for each aircraft type will be used to address variance in demand characteristics and differences in SGNSC utilization by airframe.

AGE Reliability

Carrico and Clark used MTBF and MTTR of AGE in their study. They found that MTBF and MTTR, "made very little difference in the number of aborted sorties." (Carrico and Clark, 1996:35) While Carrico and Clark's conclusion leads one to think MTBF and MTTR are unimportant, issues in fielding the new SGNSC have arisen. Of the initial carts delivered to Travis AFB, three of eight broke prior to delivery to the flightline. In addition, repairing these carts was difficult because the supply chain was not yet in place to support the SGNSC system. In actuality, the three broken carts were not repaired because the AGE shop could not get the parts. It was approximately two weeks since the AGE shop had requested parts and they had still not arrived when the site visit occurred. It is hypothesized that these issues are merely due to the fielding of a new system and that eventually these issues will be overcome as the system matures and processes are put in place to support the SGNSC system. However, sensitivity analysis will be performed on this aspect of the SGNSC system. MTBF figures are unavailable from engineering and testing data, as this requirement was not part of the acquisition contract. Between telephone interviews and correspondence with the the San Antonio Air Logistics Center (SA/ALC) engineer, MTBF for SGNSC, as a new system, is estimated to be approximately 500 hours. MTTR is estimated to be 2 hours. Again, this is based on expert opinion but serves as a starting point for sensitivity analysis.

LCOM does not model individual pieces of support equipment, so SGNSC failures will be modeled using an exponential distribution with a MTBF of 50, 100, and 500 hours. LCOM repair times will be modeled using a lognormal distribution with a standard deviation of 29% of the mean. AGE MTTR times will use a mean of 2 hours and a lognormal distribution.

In reality the supply system will likely catch up and support the SGNSC as far as repairing the carts. Pertinent data has recently become available as part of the ongoing MASS research. Legacy AGE reliability is not tracked by the Air Force, however, legacy AGE reliability data was calculated by Arthur D. Little (ADL), the contractor building the MASS concept demonstrator for AFRL/HE, using the 1995 NonElectronic Parts Reliability Data Guide (NEPRD). The 1995 guide was unavailable, however the 1991 version was readily available, and was used for reference. Discussion with the Reliability Analysis Center revealed the changes to the 1995 edition included a much larger database although the same basic assumptions held. Data for the NEPRD was collected from field data, from several different sources, applications, and environments. (NEPRD, 1991:1-3) While non-electronic parts may display wearout characteristics, for complex devices where parts are replaced upon failure, the failure rate, "may appear to be exponentially distributed if a long enough time has elapsed." (NEPRD, 1991:1-7) Later, the NEPRD goes further, stating, "for complex nonelectronic devices, the exponential distribution is a reasonable assumption." (NEPRD, 1991:1-9) ADL used data from the NEPRD to calculate MTBF times for AGE carts to be replaced by the MASS unit. The availability of reliability data, while the failures may not significantly impact the results, seem to provide a more accurate analysis of the effect of AGE reliability.

This effort will use the exponential distribution with the MTBF times as calculated by ADL using the NEPRD. It is interesting to note that, based on expert opinion, the estimated mature system reliability is 500 hours for SGNSC, however the reliability for the liquid nitrogen cart was calculated to be 1,320 hours. This does not include the additional mission flexibility of the SGNSC, but Travis does not have the mission requirements necessary to effectively assess SGNSC performance under multiple missions. One of the caveats to multi-function AGE is the inability to be at more than one place at a time, unlike the single-function AGE it replaces. Multi-function AGE carries the potential to reduce requirements by consolidating functions into a single unit, but the drawback is the inability to be in more than one place at a time. The lack of mission requirements necessary to effectively assess SGNSC performance under these conditions prevents an analysis of this aspect of performance.

Table 3: MTBF times for AGE carts

AGE Type	MTBF
Liquid Nitrogen Cart	1,320
Nitrogen Cylinder Cart	6,161
High Pressure Air Compressor Cart (MC-1A)	665

Travel Time

Havlicek stated that AGE travel time could have both a statistically and practically significant effect on mission effectiveness.(Havlicek, 1997:83) He used two constant travel times of 15 and 45 minutes.(Havlicek, 1997:52) Havlicek raised the importance of addressing travel time in an AGE study, and that the variability of travel times could have a significant effect.

The intent of the current thesis is to apply a needs based methodology to determine AGE requirements. To incorporate travel times, a delivery delay was incorporated into the LCOM model. Travis tracks AGE delivery times and according to the latest information available, 80% of AGE deliveries are within 10 minutes, and 99% of AGE deliveries are within 20 minutes. A minimum delivery time was unavailable as was the exact distribution. An assumption was made that 100% of the time maintenance would call for SGNSC support ten minutes prior to actually needing the SGNSC. The travel time was modeled in LCOM with a notional minimum travel time of 5 minutes and another point at 10 minutes. 80% of the delivery times will be linearly interpolated between 5 and 10 minutes. The remaining 20% of the delivery times linearly interpolated between 10 and 20 minutes, with the upper bound set at 20 minutes. Figure 1 visually illustrates the delivery delay distribution modeled in LCOM for this effort.

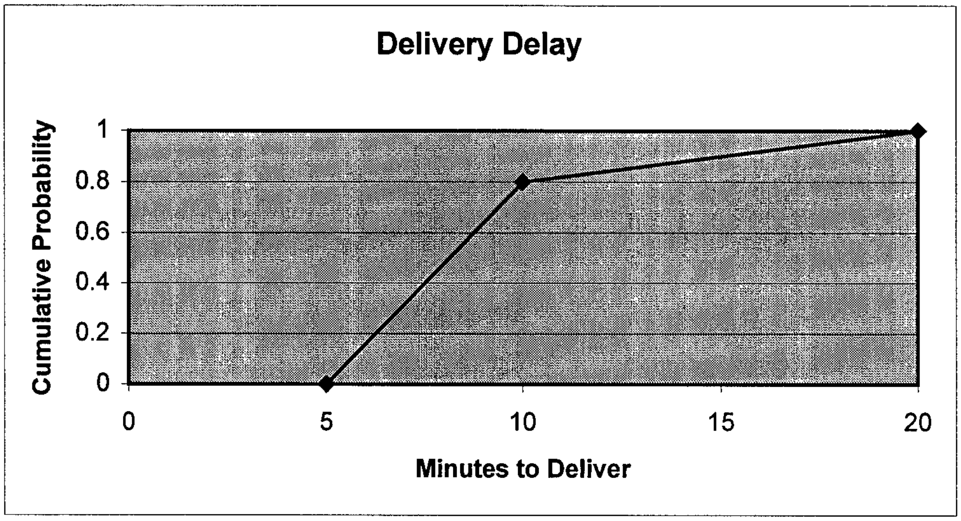

Figure 1: Cumulative Distribution Function for AGE delivery times

Resource Substitution

Flexibility of AGE is an important consideration when comparing legacy, single-function AGE to multi-function units such as SGNSC. Ideally one would model AGE as discrete elements to allow for this differentiation and allow for an analysis of the cost of combining AGE. The SME analysis of SGNSC requirements estimated a 1:1 exchange requirement to liquid nitrogen (LN_2) carts, a 1:3 exchange requirement for six/eight bottle Nitrogen carts, and the potential for also replacing MC-1A (hi-pac) units. Unfortunately, the base of study, Travis AFB, does not use Nitrogen bottle carts or MC-1A units. While they do have MC-1A units, the AGE shop and flightline crew chiefs stated they do not use them. This conforms to policy against using air vice nitrogen in corrosion prone systems. Therefore, while LCOM retains the ability to substitute resources and collect results, it was not used in this effort because AGE consolidation is not an issue at Travis. This could be incorporated into future efforts relatively easily to address questions of AGE flexibility, particularly in the case of the Modular Aircraft Support System (MASS), a program that proposes to combine functions of power generation, hydraulics, and air conditioning into one unit.

SGNSC Users

In terms of modeling users of the SGNSC resource, aircraft will be the SGNSC users, or calling population. The size of the population is determined by historical data on arrivals and departures from Travis AFB. Aircraft throughput for Travis was provided by SMSgt Jorgenson from the AMC HQ analysis shop. Data from 1 Sep 98 through 30 Jul 00 (100 weeks) was collected and analyzed. The aircraft assigned to Travis are C-5's and KC-10's. However, the base serves many different types of aircraft on a daily basis, approximately 500 departures per month. The heaviest users of Travis are KC-10 and C-5 aircraft, with an average 68% of all departures. There are also C-17, C-141, C-9, C-21, C-130, KC-135, and Commercial aircraft that use Travis. These are only the aircraft that visit the base, not necessarily the calling population.

Upon further investigation, SMSgt Imlay, the AGE Flight Chief at Travis, stated that transient aircraft use very little nitrogen and that they could be adequately served with one primary SGNSC and one spare, for a total of two SGNSC. This makes sense, as transient aircraft typically will temporarily fix something until they can get to home station where they can perform a permanent fix. Assuming transient aircraft can be adequately serviced with two SGNSC, one primary and one spare, this study excludes transient aircraft and concentrates on the demands of Travis's C-5 and KC-10 aircraft. This simplifies the model and facilitates extensibility of the methodology to other bases, aircraft, and AGE. This methodology extensibility was a primary consideration for this research effort.

The historical throughput data was analyzed to create a flying schedule for LCOM. After this extensive review, it was determined that aircraft flying schedules from the standard template that Travis currently uses would be more suitable in this study. The desire to allow extensibility to other bases and aircraft made using the flying template much more desirable. It is easier to use and is adequate for planning purposes. The use of historical throughput data, while initially desirable and thought to provide a good insight, requires extensive data manipulation and formatting to use effectively. Using the standard flying template minimizes the amount of time spent building aircraft flying schedules, and has a big impact when modeling multiple aircraft and locations. It also allowed higher customization in the form of aircraft launch windows to model potential clustering of AGE requirements.

Aircraft that are in preflight status were given a higher priority for nitrogen than all other tasks requiring nitrogen. This allows the preflight aircraft to preempt other tasks that require nitrogen, similar to what would happen during a "red streak," or short notice, high-priority maintenance on a flightline if there were not enough resources to go around. If this happens on an actual flightline, the lower priority task would be preempted to service the flyer. The LCOM model accurately reflects this situation. (Cronk, 58)

Failure Data

G081 (Gee-oh-eighty-one) is the maintenance data collection database for heavy aircraft and is key to the success of this effort. A page-by-page review of all applicable Technical Orders (T.O.'s) for each airframe is beyond the scope of this effort. SME's from the career field familiar with the airframe were interviewed to determine the WUCs requiring SGNSC support. If the WUC requires SGNSC support, WUCs will be used and matched against SGNSC requirements. Distributions are constructed based on the demand for SGNSC derived by G081 data and field interviews. Data from G081 is gathered by aircraft type. One issue with GO81 is the time necessary to complete the maintenance task. This includes all maintenance, not just the time necessary for nitrogen servicing. Only the total time is collected in the maintenance data system. For those work unit codes, Field interviews were used to determine appropriate nitrogen service times.

The WUC is the initial data flag. Each job includes the WUC and time taken for the repair job. The time taken to complete the job will determine the mean time for the job length. An assumption of unconstrained maintenance availability is necessary to focus on analysis of effects of changes to the SGNSC quantities. Data collected from G081 was the actual number of occasions that systems requiring nitrogen were serviced. Distributions are based on these maintenance intervals. It is assumed that maintenance will be available according to the same priority schedule and that nitrogen will be required in a similar manner. This assumption may or may not hold in a wartime environment, however, it is necessary as data for wartime consumption is not available. Data will be aggregated to the fleet for an overall distribution.

Failure data was extracted from G081 by WUC and aggregated to include the number of failures, MTTR, and the mean time to service, as nitrogen consumption is not necessarily required for the entire task time. This is an acceptable assumption, as it reflects reality on the flightline; technicians will not call for the nitrogen cart until they require it. A majority of the components that require nitrogen servicing are part of the aircraft landing gear system, and failures are more accurately reflected if defined by number of landings as opposed to the standard number of flying hours. Modifications to the database will accommodate this failure pattern. Historical aircraft arrivals to Travis were compared to the number of failures recorded in G081 for the same period to arrive at the number of failures per number of landings. An exponential distribution was used to model the failure rates of these nitrogen systems. The failure rates as determined by system with task and service times are given in Tables 4 and 5. Basic postflight (BPO) and preflight service intervals are interpreted through interviews with flightline personnel, as nitrogen servicing is often undocumented.

Table 4: KC-10 Task/N_2 Service Times and Number of Landings per Action

WUC	KC-10 System	Task Time- Hrs.	Service Time	Landings/ Action
13DAB	MLG	2.75	0.35	8.82
13DBB	NLG	2.75	0.35	16.17
03200	BPO	4.67	0.88	0.5
03100	PRE	0.77		0.5
45ABH	Accumulator	0.87		200
13AAO	MLG strut	1.12		12.13
13BAO	NLG strut	1.12		12.13
13AEO	Centerline landing gear	1.12		19.4
46GJO	Boom pneumatic disconnect	1.25		7.46

Table 5: C-5 Task/N_2 Service Times and Number of Landings per Action

WUC	C-5 System	Task Time- Hrs.	Service Time-Hrs	Landings/ Action
3100	Preflight	0.77		0.5
3200	Throughflight	0.5		0.5
3210	BPO	2		0.5
13AAA	Shock Strut Assembly	2.8	0.75	16.44
13FCN	Ldg Gr Strg Actuator	2.7	0.75	411
13LA*	MLG Tire	2	0.35	.83
13LC*	NLG Tire	2	0.35	6.42
24ALP	APU Accumulator	3.95	0.88	206
91AAF	Slide bottles	1.35		206
11LCH	Crew Entry door accumulator	2.8	0.88	206
11LCK	Crew Entry door accumulator	2.8	0.88	250

Output

The percentage and number of cancelled missions is a more immediate, readily identifiable reflection of AGE availability on mission effectiveness than FSE. If an aircraft mission is cancelled, then there is a very real penalty for not having AGE available. All other resources are assumed to be unconstrained to isolate SGNSC and allow analysis of SGNSC effectiveness. Flight Sortie Effectiveness or Mission Capability are not as closely related to AGE availability, and it is the author's opinion that mission capability can suffer some, but the cost of AGE is not comparable to the cost of a lost mission. The number/percentage of cancelled missions is examined for statistical and practical significance.

Utilization of AGE is collected to give the users an expectation of usage. The proposition of an overabundance of AGE is addressed examining utilization and AGE wait time. At issue is not necessarily utilization, although this will give the decision makers an idea of usage, but the ability of AGE to meet mission requirements. The focus on utilization does not consider the impact of multiple requests. The capacity to handle periods of high demand is expected to be the main driver of AGE and a natural means for sizing an AGE force such as SGNSC.

IV. Results

A variety of scenarios were defined to examine two factors of interest: SGNSC inventory levels and SGNSC reliability. AMC has projected 18 SGNSC units for Travis, the base of study. The transient aircraft mission of Travis requires SGNSC. However, this mission is neither a focus of this study nor a significant user of local SGNSC. Two SGNSC were detailed to support the transient mission to account for this real concern. Three SGNSC inventory levels were examined: 5, 10, and 15. For each inventory level, a SGNSC MTBF of 50, 100 and 500 hours was modeled.

Travis AFB operations were modeled for a 5-year period. As aircraft complete missions failures occur. Those failures requiring SGNSC were modeled. SGNSC failures reduce the pool of SGNSC available to perform modeled aircraft maintenance. Inadequate inventory or depleted inventory due to SGNSC failures may impact mission effectiveness. Peacetime and surge flying scheudles were modeled.

Data collected from this 5-year simulation represent steady-state data. As with most steady-state simulations, the initial period of the simulation, called the transient or warm-up period, is not indicative of steady-state conditions. Including transient data in steady-state calculations introduces bias. The transient period, conservatively determined to be the first 6-months of the simulated time frame was removed (Law and Kelton, 2000:499-501).

Final statistics are based on 30 replications, each with the initial transient removed. Scenarios are compared based on 95% confidence intervals. As noted in the results below, various confirmatory simulations were conducted as dictated by the initial analysis of the simulation data. The primary data examined are SGNSC utilization, mission effectiveness, and time spent waiting for SGNSC assets to become available.

Peacetime Results

Initial results were impressive and insightful. At an inventory of 5 SGNSC with a 50 hour MTBF, aircraft sorties did not suffer at all. A subsequent confirmatory run reducing the inventory to 3 still did not affect the flying schedule. SGNSC utilization was only 29%, which included travel time. LCOM limitations necessitated including travel time in utilization rate. However, wait time increased dramatically. Wait time increased from an acceptable average 4.4 hours per month with 5 SGNSC, to a likely unacceptable 69.2 hours per month with 3 SGNSC. This confirmed nitrogen utilization is not very high.

People are the most valuable resource on the flightline, and if your people are waiting for equipment, they can't work. Greater coordination between AGE and maintenance holds promise in leveling out demand by forecasting nitrogen requirements, but the demands on maintenance are legion. The ability to plan AGE consumption is merely held out as an opportunity for future improvement, especially regarding deployments. The current command structure and demands for attention on maintenance force this study to focus on the most efficient and effective utilization of AGE within existing command structures and maintenance concepts.

Therefore, the focus changed from one of ability of aircraft to meet the schedule to one of reducing wait time to an acceptable level of pain. General goals in the service sector are an 80% utilization rate for resources. Some sectors cannot and probably should not try to attain this kind of utilization. A more appropriate comparison would be with emergency services. An emergency ambulance has a utilization of approximately 30%. (Fitzimmons, 1997: 517) However, if someone must wait for an ambulance, his or her family may not be comforted knowing an ambulance fleet was reduced to increase overall utilization. The flightline presents a somewhat similar scenario; we do not want to wait on support equipment when trying to restore aircraft to a mission capable status. The consequences of waiting for AGE on the flightline outweigh the advantages gained by higher utilization of AGE.

The failure rates of SGNSC were manipulated to determine the sensitivity of demand. MTBF times of 50, 100 and 500 hrs were used. The differences were very small as illustrated in Figure 2.

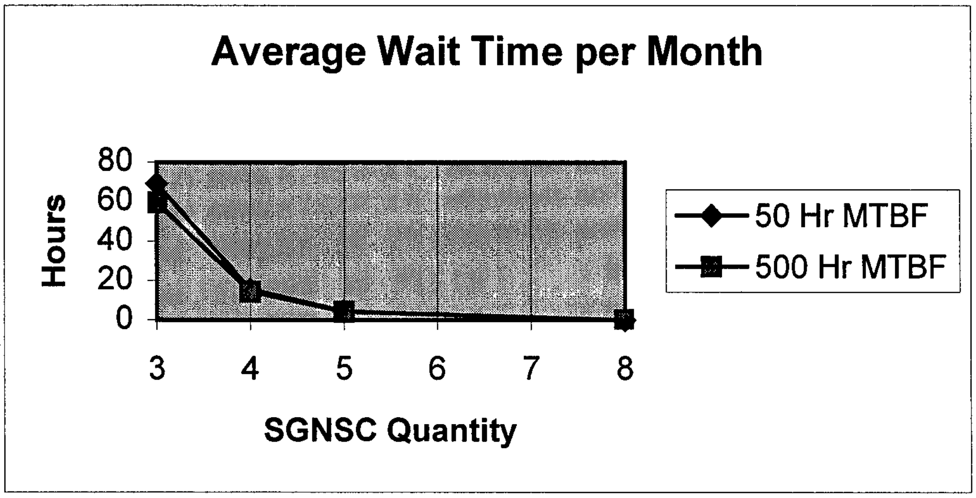

Figure 2: Comparison of Quantity and MTBF on Wait Time

SGNSC was not very sensitive to changes in reliability as Figure 2 aptly shows. It is much more sensitive to the quantity of SGNSC. An additional run with an inventory of four was included in Figure 2. Wait times do not begin until an inventory drops and a quantity of five SGNSC is reached. Wait time increases very quickly after that, as Table 6 shows.

Table 6: Effect of SGNSC Quantity on Wait Time and Utilization (Peacetime)

SGNSC	Average wait (hrs/month)	Utilization
3	59.6	28.9%
4	14.4	21.6%
5	4.4	17.9%
8	0	11.2%
10	0	9%
15	0	6%

A comparison of confidence intervals by SGNSC MTBF in Table 7 shows that an inventory of 5 SGNSC or higher results in no statistical difference in wait time with 95% confidence. Even when there is a statistical difference, the practical differences are minor until SGNSC is constrained to 3 units.

Table 7: Difference in wait time at 50 and 500 hr MTBF (Peacetime)

95% CI	3/50	3/500	4/50	4/500	5/50	5/500	8/50	8/500
Lower	68.25	58.83	15.15	14.13	4.40	4.32	0.07	0.07
Upper	69.89	60.23	15.84	14.59	4.66	4.61	0.10	0.09

Surge Results

While the peacetime results are illuminating, they do not address the ability to meet maximum demand. The military, by nature, requires excess capacity. The ability to respond quickly and with force during wartime is necessary. The unfortunate side effect of this capability is the apparent lack of utilization of capacity during a peacetime posture. Using an LCOM surge template, the model was shifted into a fly-when-ready mode. SGNSC quantities of 5, 10, and 15 were again initially used to examine sensitivities. Additional confirmatory runs with quantities of 11 and 12 SGNSC were added to further clarify wait times and utilization. MTBF times were initially 500 hours, but additional runs with 50 hour MTBF times were conducted to verify SGNSC availability under maximum usage scenarios at quantities of 11 and 12. The results of the comparison between 50 and 500 hour MTBF times under a surge scenario are very similar to the peacetime results. While Table 8 shows statistical differences at 95% confidence, the practical differences are again minor at these inventory levels.

Table 8: Difference in wait time at 50 and 500 hour MTBF (Surge)

95% CI	11/50	11/500	12/50	12/500
lower	8.80	7.88	2.96	2.73
upper	9.25	8.20	3.18	2.90

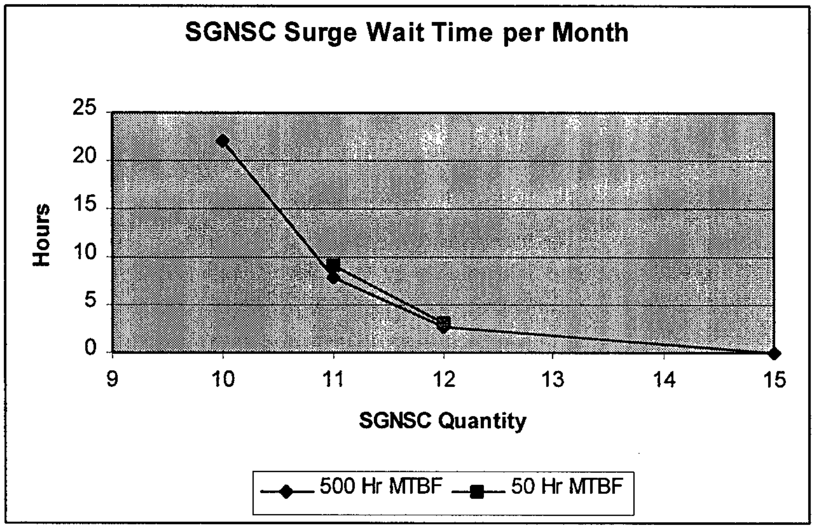

Figure 3: Comparison of MTBF times and Quantity on Wait Times (Surge)

The effect of varying reliability of the SGNSC carts is minor compared to varying the quantity of SGNSC. The wait time "knee in the curve: occurs when SGNSC inventory falls to 12 carts. Reduced further, to 11 and then 10 units, wait times increase dramatically. An inventory of 5 SGNSC gives an impressive 94% utilization! However, just as we do not want to wait for an ambulance, we cannot accept the waiting time associated with this tremendous utilization. Utilization and wait times for the various quantities of SGNSC are listed in Table 9.

Table 9: Effect of SGNSC Quantity on Wait Time and Utilization (Surge)

SGNSC	Average wait (hrs/month)	Utilization
5	2,860	94%
10	22	51%
11	8	46%
12	2.8	42%
15	0	34%

The effect of changing to a fly-when-ready mode of operations exposes SGNSC to a much higher demand rate. What is apparently a vastly underutilized fleet of 10 units with a dismal peacetime utilization of 9% explodes during surge to 51%, with an unacceptably low overall average wait time of 22 hours per month.

Implications

SGNSC is currently being fielded. Unit reliability is uncertain but historical AGE data and MASS research yield reasonable bounds for MTBF data. This study fails to judge MTBF as a prime driver for SGNSC BOI.

Utilization and wait time are inversely related. High utilization should not become a factor for SGNSC BOI as it comes with too high a cost to the maintainer.

The BOI driver appears to be the unit surge mission While still yielding excess peacetime capacity, the resulting inventory levels appear a fairly nice reduction in planned inventory levels (25% in this case).

V. Recommendations

AGE utilization is very low, and demands for AGE resources overstated. The current overabundance of AGE on the flightline is unaffordable in today's Air Force. The methodology yields a useful, quantitative basis in determining AGE levels for new and existing programs and should be used in conjunction with current methods for more insight into AGE inventory levels.

The model promotes a reduction of AGE to at least an inventory of 12 plus 1 for transient aircraft. MTBF effects are minimal and it is postulated that a spare for the transient support is unnecessary provided transient support may borrow a SGNSC from the home station AGE shop. This would mean an inventory of 13 SGNSC vice the current 18 programmed for Travis by AMC. The current contract for SGNSC, at $20 million for 570 carts, is approximately $35,000 per cart. A reduction of 5 SGNSC would mean approximately $175,000 reduction in acquisition costs, not including maintenance costs. If the model could be extended the possibility of a 28% reduction in SGNSC acquisition costs would amount to approximately $5.6 million over the life of the contract. These reductions in levels of AGE Air Force wide would also have the benefit of cost avoidance in operations and maintenance costs.

While the results are positive, this study only attempts to estimate actual requirements. These results do not incorporate War Reserve Material, deployment, other potential demands or outside limiting factors, only demands anticipated at Travis AFB, CA. It must be remembered that these are estimates only, and should be taken into consideration with other factors and experience before applying any results to the field. However, the results give a reasonable estimation of the potential cost savings in reduced procurement costs.

One of the issues in optimizing a certain part (SGNSC) of an interrelated system are the effects on other parts of the system, or flightline. Reducing SGNSC may increase utilization, but AGE drivers may not be enough; waiving reliability requirements may not have a serious effect on wait time, but AGE shop manpower may need to be increased. This study examines the effects of reducing AGE levels to meet expected mission requirements. When a resource pool is reduced, other issues may arise.

Redeployment/Redistribution

One opportunity, if command and control issues could be addressed, would be the option of redeploying AGE assets from other bases. In the case of SGNSC, acceptable peacetime waits resulted in a SGNSC inventory of 5 units. A minimal wait during wartime resulted in a SGNSC inventory of 12 to meet mission requirements. What if there were 8 SGNSC at Travis and 8 units at another base, say Altus? If Travis surges, Altus aircraft could bring 4 SGNSC with them to meet the increase in demand. Again, this assumes a second, similar base and does not address SGNSC needs at the other base and a deployed location. However, this concept may provide an opportunity to reduce AGE levels significantly.

Simulation Software and LCOM

LCOM was initially thought to be an excellent model for modeling a flightline environment. Flying schedules were readily translated into LCOM protocols, numerous WUCs were already in the model, and it is a queuing simulation with numerous resources and extensive data analysis. However, after using LCOM, while it is an effective model and has numerous advantages, there were great difficulties in tweaking the model to examine the particular parameters desired. While LCOM can model resources, it does not identify resources as individual entities, the resource is a pool. This can be an issue when higher resolution is desired, such as monitoring the MTBF of a particular piece of AGE. The ability to add in special code when necessary is highly desired. LCOM is very powerful, but does not have the flexibility of some of the general purpose simulation software commercially available, such as modeling multiple locations. LCOM is already built, and has excellent interaction with existing maintenance data collection systems. This gives it a great advantage, especially when doing a major study, but lacks the resolution desired when asking detailed questions. It is complicated, and the user documentation is poor. Without the expert assistance of the LCOM shop at ASC/ENMS I would still be trying to figure out LCOM. Once a model is built, LCOM is a dream to run and operate. The user interface is excellent. However building the model is an exercise in patience.

Further Research

To preserve flexibility of the model, allow easier programming of the model, and arrive at a more accurate answer, it is recommended that in the future a commercially available general purpose simulation software package such as Awesim or Arena be used. Given the difficulties anticipated in multi-base coordination of AGE assets, the model could be confined to single base applications while preserving a multi-base option in the future if desired. More definitive research into surge operations and their effects on the flying schedule is needed, as is actual nitrogen consumption during preflights and postflights. These are a main drivers of SGNSC utilization, and may also have an effect on other flightline AGE utilization. The effect of interactions between AGE units and the impact of multi-function AGE was not addressed in this research but could be incorporated in future models.

Summary

This thesis was an attempt to define and demonstrate a usable methodology for assessing AGE utilization, need, and the impact of AGE on mission effectiveness. The research met this objective. An important issue discovered in the analysis of AGE inventory sizing was the wait time for AGE. A queuing simulation is ideally suited to the fluid environment of the flightline and WUCs are the most accurate indicator available to derive AGE consumption. Adjusting AGE inventory to minimize wait time or keep it down to an acceptable level is the prime measure of AGE mission effectiveness.

This study is not a mathematical formula to quantify the number of SGNSC carts needed on the flightline. This research is a more objectively oriented approach to identify those aspects of actual AGE needs on flightline operations that have the greatest impact and the relative consequences of adjusting AGE inventory levels. This thesis has illuminated the issues and areas that are worth a more detailed exploration. A side benefit has been the discovery that there really is too much AGE in the field.

Appendix A

Legacy AGE reliability data was compiled by Arthur D. Little during MASS research. All data is from the 1995 Nonelectronic Parts Reliability Data Guide.

Appendix A							
This table was assembled by Arthur D. Little as part of the ongoing MASS research.							
Parts reliability was calculated using the 1995 Non-Electronic Parts Reliability Guide.							
AGE Cart Reliability							
This analysis contains of the following carts							
- Hydraulic Test Stand Cart (TTU-228E1B)							
- Gas Turbine Generator Cart (AM32-60A)							
- Diesel Generator Cart (AM32A-86D)							
- High Pressure Air Compressor Cart (MC-1A)							
- Low Pressure Air Compressor Cart (MC-2A)							
- Air Cycle Cooling Cart (AM32C-10C)							
- Flood Light Cart (NF-2D)							
- Liquid Nitrogen Cart (A0411000)							
- Nitrogen Cylinder Cart (NG-02)							
Hydraulic Test Stand Cart (#TTU-228E1B)							
Failures per Million Hours of Usage =	**3,134**						
Mean Time Between Failures (MTBF) =	**319**						
Parts Description	**Parts Quantity**	**Failures per Million Hours**	**Qty x Fail per Million Hours**	**MTBF x Qty (Hours)**	**Reliability Source, Corr.**	**Weight (pounds)**	**Footprint (sq. ft.)**
Hydraulic Cart	1	6,667	6,667	150	Mil. Spec.	5,740	61
Hydraulic System	----	----	----	----	----		
High Pressure Pump-Axial Piston	3	53.619	160.857	6,217	106, 104*		
Pressure Regulator	3	8.324	24.972	40,045	110*		
Relief Valve	3	1.479	4.437	225,378	155*		
Low Pressure Boost Pump	3	40.410	121.230	8,249	104*		
Check Valve-Poppett Type	3	13.985	41.955	23,835	150, 151*		
High Pressure Filter	3	6.716	20.148	49,633	90*		
Differential Pressure Indicator	3	1.030	3.090	323,625	66*		
Low Pressure Filter	6	6.716	40.296	24,816	90*		
Drain Plug	3	0.169	0.507	1,972,387	69, 69		
Filter Bleed Valve	3	1.362	4.086	244,738	154*		
Sight Tube	3	7.364	22.092	45,265	65, 65*		
Light Assembly	3	10.264	30.792	32,476	87*		
Thermal Relief Valve	3	1.479	4.437	225,378	155*		
Relief Valve-Low Pressure	3	1.479	4.437	225,378	155*		
Piping, ft	40	0.729	29.160	34,294	150*		
Weld Joint	92	0.011	1.012	988,142	161		
Dust Cap	3	0.169	0.507	1,972,387	69, 69		
Dry Break Coupling	6	8.830	52.980	18,875	60*		
Compression Fitting	40	0.169	6.760	147,929	69, 69		
Oil Cooler-Air to Oil	3	1.634	4.902	203,998	74*		
Bypass Valve	3	1.479	4.437	225,378	155*		
Flow Control Valve	6	7.364	44.184	22,633	153*		
Fill System Pump-Centrifugal	1	46.711	46.711	21,408	104*		
Motor DC	1	9.132	9.132	109,505	58		
Battery-24 Volt Lead Acid	1	27.027	27.027	37,000	9*		
Switch On-Off	1	5.165	5.165	193,611	139*		
Fill Valve-Push Button	3	32.836	98.508	10,151	153, 151*		
Relief Valve-Variable	2	1.479	2.958	338,066	155*		
Check Valve	1	13.985	13.985	71,505	150, 151*		
Filter-10 Micron	1	6.716	6.716	148,898	90*		
Differential Pressure Indicator	1	1.030	1.030	970,874	66*		
Reservoir	1	6.623	6.623	150,989	142*		
Level Gauge	1	11.905	11.905	83,998	81*		
Vent	1	1.780	1.780	561,798	160*		
Drain Valve	1	1.438	1.438	695,410	152*		
Filler Cap	1	13.300	13.300	75,188	153, 153*		
Pressure Check Valve	3	13.985	41.955	23,835	150, 151*		
Flow Meter	3	7.938	23.814	41,992	66*		
Light Assembly	3	10.264	30.792	32,476	87*		
Pressure Gage-Bourdon Tube	3	1.020	3.060	326,797	66*		

Temperature/Pressure Compensator	3	6.623	19.869	50,330	142*		
Gage Selector Valve	3	1.438	4.314	231,803	152*		
Duplex Gauge	3	2.040	6.120	163,399	66, 2X*		
Thermoswitch	3	0.605	1.815	550,964	137*		
Temperature Gauge	3	1.959	5.877	170,155	66*		
Temperature Sensor	3	1.069	3.207	311,818	122, 10X*		
Horn	3	1.782	5.346	187,056	77*		
Pressure Switch	3	6.486	19.458	51,393	132*		
Fluid Sampling Valve	3	7.364	22.092	45,265	153*		
Hose (ft)	90	0.210	18.900	52,910	78*		
Diesel Engine	1	167.969	167.969	5,953	55*	—	—
Glow Plug	6	66.474	398.844	2,507	78*		
Glow Plug Pushbutton Switch	1	8.094	8.094	123,548	134*		
Glow Plug Indicator Sensor	1	1.069	1.069	935,454	122, 10X*		
Glow Plug Indicator Gauge	1	1.959	1.959	510,465	66*		
Starting System-24VDC	1	5.137	5.137	194,666	128, 52*		
Battery-24 Volt Lead Acid	1	27.027	27.027	37,000	9*		
Alternator	1	36.784	36.784	27,186	75*		
Manual Starting System	1	33.624	33.624	29,741	6*		
Exhaust System	1	77.219	77.219	12,950	102, 94		
Circuit Breaker	6	0.756	4.536	220,459	21		
Fuel Tank	1	6.321	6.321	158,203	142*		
Sump Drain Valve	1	1.438	1.438	695,410	152*		
Fuel Level Gauge	1	6.718	6.718	148,854	65*		
Speed Changer-Gear Type	1	11.726	11.726	85,281	69*		
Flexible Coupling	6	1.762	10.572	94,589	45*		
Clutch	6	42.539	255.234	3,918	25*		
Heater	1	4.878	4.878	205,002	75*		
Thermostat	1	3.852	3.852	259,605	146*		
Fan Blade	1	0.492	0.492	2,032,520	58*		
Thermostat	1	3.852	3.852	259,605	146*		
Manual Throttle	1	10.000	10.000	100,000			
Manual Choke	1	10.000	10.000	100,000			
Starter Switch	1	8.120	8.120	123,153	134*		
Radiator	1	1.634	1.634	611,995	74*		
Thermostat	1	3.852	3.852	259,605	146*		
Tachometer	1	10.682	10.682	93,615	90		
Hourmeter	1	5.028	5.028	198,886	95, 95/100*		
Oil Pressure Gauge	1	1.020	1.020	980,392	66*		
Pressure Sensor	1	6.850	6.850	145,985	122*		
Head Temperature Gauge	1	1.959	1.959	510,465	66*		
Temperature Sensor	1	1.069	1.069	935,454	122, 10X*		
Oil Temperature Gauge	1	1.959	1.959	510,465	66*		
Temperature Sensor	1	1.069	1.069	935,454	122, 10X*		
Ammeter	1	0.366	0.366	2,732,240	92*		
Heater Control, Thermostat	1	3.852	3.852	259,605	146*		
Water Pump	1	342.376	342.376	2,921	108*		
Hose (ft)	4	0.210	0.840	1,190,476	78*		
V-Pulley	2	12.609	25.218	39,654	102*		
Fan Belt	2	16.835	33.670	29,700	14*		
Electric Power Harness	—	—	—	—	—	—	—
Power Cable (ft)	30	2.203	66.090	15,131	18, 10X*		
Connector	2	1.477	2.954	338,524	34, 10X*		
Trailer and Housing	—	—	—	—	—	—	—
Frame	1	19.231	19.231	51,999	38*		
Axle	2	9.539	19.078	52,416	8*		
Spring-Leaf Type	4	35.912	143.648	6,961	127*		
Parking Brake	2	4.274	8.548	116,986	15*		
Brake Handle	1	35.587	35.587	28,100	131*		
Tiedown Fitting	4	0.067	0.268	3,731,343	20*		
Pintle Hook	1	0.737	0.737	1,356,852	149-95		
Frame Welded Control Panel	1	2.000	2.000	500,000			
Wheel	4	0.390	1.560	641,026	239-95		
Tire	4	14.960	59.840	16,711	218-95		
Housing-16 ga Steel	1	3.698	3.698	270,416	78*		
Fastener-1/4 Turn	12	6.542	78.504	12,738	59*		
Handle	4	0.067	0.268	3,731,343	20*		

Battery Charger	1	36.784	36.784	27,186	75*		
Ammeter Gauge	1	0.366	0.366	2,732,240	92*		
Overtemperature Control	1	3.852	3.852	259,605	146*		
Low Oil Pressure Control	1	6.850	6.850	145,985	122*		
Exhaust Temperature Sensor	1	1.069	1.069	935,454	122, 10X*		
Exhaust Temperature Gauge	1	1.959	1.959	510,465	66*		
Tachometer	1	10.682	10.682	93,615	90*		
Ambient Air Temperature Gauge	1	1.959	1.959	510,465	66*		
Ambient Air Temperature Sensor	1	1.069	1.069	935,454	122, 10X*		
Hourmeter	1	5.028	5.028	198,886	95, 95/100*		
Governor	1	30.000	30.000	33,333			
Frequency Regulator	1	2.652	2.652	377,074	109*		
Exhaust System	1	77.219	77.219	12,950	102, 94		
Fuel Tank	1	6.321	6.321	158,203	142*		
AC Generator 120/208V, 3 Ph	1	18.868	18.868	53,000	70*		
Voltage Regulator	1	14.217	14.217	70,338	109, 2X*		
Main Contactor	1	3.649	3.649	274,048	21*		
Inlet Air Temperature Gauge	1	1.959	1.959	510,465	66*		
Inlet Air Temperature Sensor	1	1.069	1.069	935,454	122, 10X*		
Outlet Air Temperature Gauge	1	1.959	1.959	510,465	66*		
Outlet Air Temperature Sensor	1	1.069	1.069	935,454	122, 10X*		
DC Transformer 28 VDC	1	8.291	8.291	120,613	100*		
Rectifier	1	26.005	26.005	38,454	148		
Voltage Regulator	1	14.217	14.217	70,338	109, 2X*		
Circuit Breaker	4	3.649	14.596	68,512	21*		
Voltage Protector	4	9.930	39.720	25,176	21*		
Frequency Limiter	2	7.149	14.298	69,940	21*		
Current Limiter	2	7.149	14.298	69,940	21*		
AC Voltmeter	1	34.666	34.666	28,847	95*		
DC Voltmeter	1	21.085	21.085	47,427	95*		
AC Ammeter	1	27.188	27.188	36,781	92*		
DC Ammeter	1	14.296	14.296	69,950	92*		
AC Kilowatt Meter	1	73.571	73.571	13,592	94*		
Inlet Air Temperature Gauge	1	1.959	1.959	510,465	66*		
Temperature Sensor	1	1.069	1.069	935,454	122, 10X*		
Outlet Air Temperature Gauge	1	1.959	1.959	510,465	66*		
Temperature Sensor	1	1.069	1.069	935,454	122, 10X*		
Terminal Block	8	0.381	3.048	328,084	143*		
Frequency Meter	1	27.364	27.364	36,544	93*		
Relay	12	12.093	145.116	6,891	111*		
Switch	12	5.165	61.980	16,134	138*		
Pneumatic Blower	1	6.253	6.253	159,923	65		
Bleed Control Valve	1	7.364	7.364	135,796	153*		
Flow Restrictor	1	528.074	528.074	1,894	153, 151*		
Flexible Ducting	1	1.032	1.032	968,992	77*		
Quick Disconnect	1	8.830	8.830	113,250	60*		
Bleed Air Pressure Gauge	1	7.194	7.194	139,005	66*		
Bleed Air Pressure Sensor	1	6.850	6.850	145,985	122*		
Bleed Air Flow Meter	1	9.549	9.549	104,723	93, 2X*		
Bleed Air Flow Sensor	1	60.606	60.606	16,500	122*		
Bleed Air Temperature Sensor	1	1.069	1.069	935,454	122, 10X*		
Bleed Air Temperature Gauge	1	1.959	1.959	510,465	66*		
Trailer and Housing	----	----	----	----	----	----	----
Frame	1	19.231	19.231	51,999	38*		
Axle	2	9.539	19.078	52,416	8*		
Spring-Leaf Type	4	35.912	143.648	6,961	127*		
Parking Brake	2	4.274	8.548	116,986	15*		
Brake Handle	1	35.587	35.587	28,100	131*		
Tiedown Fitting	4	0.067	0.268	3,731,343	20*		
Pintle Hook	1	0.737	0.737	1,356,852	149-95		
Frame Welded Control Panel	1	2.000	2.000	500,000			
Wheel	4	0.390	1.560	641,026	239-95		
Tire	4	14.960	59.840	16,711	218-95		
Housing-16 ga Steel	1	3.698	3.698	270,416	78*		
Fastener-1/4 Turn	12	6.542	78.504	12,738	59*		
Handle	4	0.067	0.268	3,731,343	20*		
Diesel Generator Cart (#AM32A-86D)							

Glow Plug Indicator Gauge	1	1.959	1.959	510,465	66*		
Starting System-24VDC	1	5.137	5.137	194,666	128, 52*		
Battery-24 Volt Lead Acid	1	27.027	27.027	37,000	9*		
Alternator	1	36.784	36.784	27,186	75*		
Ammeter Gauge	1	0.366	0.366	2,732,240	92*		
Fuel Tank	1	6.321	6.321	158,203	142*		
Radiator-Air to Water	1	1.634	1.634	611,995	74*		
Water Pump	1	342.376	342.376	2,921	108*		
Thermostat	1	3.852	3.852	259,605	146*		
Hose	2	0.210	0.420	4,761,905	78*		
Fan Belt	2	16.835	33.670	59,400	14*		
V-Pulley	2	12.609	25.218	79,308	102*		
Overtemperature Control	1	3.852	3.852	259,605	146*		
Low Oil Pressure Control	1	6.850	6.850	145,985	122*		
Exhaust Temperature Sensor	1	1.069	1.069	935,454	122, 10X*		
Exhaust Temperature Gauge	1	1.959	1.959	510,465	66*		
Tachometer	1	10.682	10.682	93,615	90*		
Ambient Air Temperature Gauge	1	1.959	1.959	510,465	66*		
Ambient Air Temperature Sensor	1	1.069	1.069	935,454	122, 10X*		
Hour Meter	1	5.028	5.028	198,886	95, 95/100*		
Exhaust System	1	77.219	77.219	12,950	102, 94		
Governor	1	30.000	30.000	33,333			
Frequency Regulator	1	2.652	2.652	377,074	109*		
AC Generator 120/208V, 3 Ph	1	18.868	18.868	53,000	70*		
Voltage Regulator	1	14.217	14.217	70,338	109, 2X*		
Main Contactor	1	3.649	3.649	274,048	21*		
Inlet Air Temperature Gauge	1	1.959	1.959	510,465	66*		
Outlet Air Temperature Gauge	1	1.959	1.959	510,465	66*		
DC Transformer 28 VDC	1	8.291	8.291	120,613	100*		
Rectifier	1	26.005	26.005	38,454	148		
Voltage Regulator	1	14.217	14.217	70,338	109, 2X*		
Circuit Breaker	4	3.649	14.596	68,512	21*		
Voltage Protector	4	9.930	39.720	25,176	21*		
Frequency Limiter	2	7.149	14.298	69,940	21*		
Current Limiter	2	7.149	14.298	69,940	21*		
AC Voltmeter	1	34.666	34.666	28,847	95*		
DC Voltmeter	1	21.085	21.085	47,427	95*		
AC Ammeter	1	27.188	27.188	36,781	92*		
DC Ammeter	1	14.296	14.296	69,950	92*		
AC Kilowatt Meter	1	73.571	73.571	13,592	94*		
TR Inlet Air Temperature Gauge	1	1.959	1.959	510,465	66*		
TR Inlet Air Temperature Sensor	1	1.069	1.069	935,454	122, 10X*		
TR Outlet Air Temperature Gauge	1	1.959	1.959	510,465	66*		
TR Outlet Air Temperature Sensor	1	1.069	1.069	935,454	122, 10X*		
Terminal Block	8	0.381	3.048	328,084	143*		
Frequency Meter	1	27.364	27.364	36,544	93*		
Relay	12	12.093	145.116	6,891	111*		
Switch	12	5.165	61.980	16,134	138*		
Trailer and Housing	----	----	----	----	----	----	----
Frame	1	19.231	19.231	51,999	38*		
Axle	2	9.539	19.078	52,416	8*		
Spring-Leaf Type	4	35.912	143.648	6,961	127*		
Parking Brake	2	4.274	8.548	116,986	15*		
Brake Handle	1	35.587	35.587	28,100	131*		
Tiedown Fitting	4	0.067	0.268	3,731,343	20*		
Pintle Hook	1	0.737	0.737	1,356,852	149-95		
Frame Welded Control Panel	1	2.000	2.000	500,000			
Wheel	4	0.390	1.560	641,026	239-95		
Tire	4	14.960	59.840	16,711	218-95		
Housing-16 ga Steel	1	3.698	3.698	270,416	78*		
Fastener-1/4 Turn	12	6.542	78.504	12,738	59*		
Handle	4	0.067	0.268	3,731,343	20*		
High Pressure Air Compressor Cart (#MC-1A)							
Failures per Million Hours of Usage =	**1,503**						
Mean Time Between Failures (MTBF) =	**665**						
	Parts	**Failures per**	**Qty x Fail per**	**MTBF x Qty**	**Reliability**	**Weight**	**Footprint**

Hose (ft)	4	0.210	0.840	1,190,476	78*		
V-Pulley	2	12.609	25.218	39,654	102*		
Fan Belt	2	16.835	33.670	29,700	14*		
Tachometer	1	10.682	10.682	93,615	90		
Hour Meter	1	5.028	5.028	198,886	95, 95/100*		
Engine Oil Pressure Gauge	1	1.020	1.020	980,392	66*		
Engine Oil Pressure Sensor	1	6.850	6.850	145,985	122*		
Exhaust System	1	77.219	77.219	12,950	102, 94		
Fuel Tank-17 Gallon	1	6.321	6.321	158,203	142*		
Clutch Assembly-Dry, Single Plate	1	42.539	42.539	23,508	25*		
Governor	1	30.000	30.000	33,333			
Compressor	—	—	—	—	—	—	—
Compressor Head-2 Stage	1	33.624	33.624	29,741	26*		
Air Filter	2	3.242	6.484	154,226	89*		
Pressure Gauge	6	1.020	6.120	163,399	66*		
Pressure Relief Valve	1	1.479	1.479	676,133	155*		
High Pressure Regulator	1	2.135	2.135	468,384	110*		
High Pressure Gauge	1	1.020	1.020	980,392	66*		
Pressure Relief Valve	1	1.479	1.479	676,133	155*		
Low Pressure Regulator	1	2.135	2.135	468,384	110*		
Low Pressure Gauge	1	1.020	1.020	980,392	66*		
Compressor Oil Pressure Gauge	1	1.020	1.020	980,392	66*		
Intercooler	1	1.634	1.634	611,995	74*		
Aftercooler	1	1.634	1.634	611,995	74*		
Air Receiver	2	16.000	32.000	31,250	143, 143X2*		
Rupture Disc Assembly	2	1.000	2.000	500,000			
Air Pressure Drain Valve	1	1.438	1.438	695,410	152*		
Master Switch-On/Off Pushbutton	1	8.094	8.094	123,548	134*		
Light Switch	1	5.165	5.165	193,611	138*		
Throttle Control Valve	1	7.364	7.364	135,796	153*		
High/Low Receiver Drain Valve	1	1.438	1.438	695,410	152*		
High/Low Hose Bleed Valve	1	7.364	7.364	135,796	153*		
Backpressure Control Valve	1	7.364	7.364	135,796	153*		
Dehydrator Assembly	1	10.000	10.000	100,000			
Dehydrator Bleed Valve	1	7.364	7.364	135,796	153*		
Filter-10 Micron	1	3.242	3.242	308,452	89*		
Pressure Switch	1	6.486	6.486	154,178	132*		
Piping (ft)	12	0.729	8.748	114,312	150*		
Compression Fitting	24	0.169	4.056	246,548	69, 69		
Air Hose (ft)	60	1.032	61.920	16,150	77*		
Spring Return Reel	2	35.912	71.824	13,923	127*		
Frame and Axle Assembly	—	—	—	—	—	—	—
Frame	1	19.231	19.231	51,999	38*		
Axle	2	9.539	19.078	52,416	8*		
Spring-Leaf Type	4	35.912	143.648	6,961	127*		
Parking Brake	2	4.274	8.548	116,986	15*		
Brake Handle	1	35.587	35.587	28,100	131*		
Tiedown Fitting	4	0.067	0.268	3,731,343	20*		
Pintle Hook	1	0.737	0.737	1,356,852	149-95		
Frame Welded Control Panel	1	2.000	2.000	500,000			
Wheel	4	0.390	1.560	641,026	239-95		
Tire	4	14.960	59.840	16,711	218-95		
Housing-16 ga Steel	1	3.698	3.698	270,416	78*		
Fastener-1/4 Turn	12	6.542	78.504	12,738	59*		
Handle	4	0.067	0.268	3,731,343	20*		
Low Pressure Air Compressor Cart (#MC-2A)							
Failures per Million Hours of Usage =	**866**						
Mean Time Between Failures (MTBF) =	**1,155**						
Parts Description	**Parts Quantity**	**Failures per Million Hours**	**Qty x Fail per Million Hours**	**MTBF x Qty (Hours)**	**Reliability Source, Corr.**	**Weight (pounds)**	**Footprint (sq. ft.)**
Low Pressure Air Compressor Cart	1	2,000.000	2,000.000	500		875	33
Gasoline Engine	1	167.969	167.969	5,953	55*		
Fuel Pump	1	23.121	23.121	43,251	103*		
Starting System-12 VDC	1	5.137	5.137	194,666	128, 52*		
Battery-12 Volt Lead Acid	1	27.027	27.027	37,000	9*		
Ammeter Gage	1	0.366	0.366	2,732,240	92*		

Air Filter	2	3.242	6.484	154,226	89*		
Pressure Gauge	6	1.020	6.120	163,399	66*		
Pressure Relief Valve	1	1.479	1.479	676,133	155*		
Low Pressure Regulator	1	2.135	2.135	468,384	110*		
Low Pressure Gauge	1	1.020	1.020	980,392	66*		
Compressor Oil Pressure Gauge	1	1.020	1.020	980,392	66*		
Constant Speed Unloader	1	25.768	25.768	38,808	110*		
Air Receiver	1	16.000	16.000	62,500	143, 143X2*		
Rupture Disc Assembly	2	1.000	2.000	500,000			
Air Pressure Drain Valve	1	1.438	1.438	695,410	152*		
Master Switch-On/Off	1	8.094	8.094	123,548	134*		
Light Switch	1	5.165	5.165	193,611	138*		
Throttle Control Valve	1	7.364	7.364	135,796	153*		
Filter-10 Micron	1	3.242	3.242	308,452	89*		
Pressure Switch	1	6.486	6.486	154,178	132*		
Piping (ft)	12	0.729	8.748	114,312	150*		
Compression Fitting	24	0.169	4.056	246,548	69, 69		
Air Hose (ft)	30	1.032	30.960	32,300	77*		
Spring Return Reel	1	35.912	35.912	27,846	127*		
Frame and Axle Assembly	----	----	----	----	----	----	----
Frame	1	19.231	19.231	51,999	38*		
Axle	1	9.539	9.539	104,833	8*		
Spring-Leaf Type	2	35.912	71.824	13,923	127*		
Parking Brake	2	4.274	8.548	116,986	15*		
Brake Handle	1	35.587	35.587	28,100	131*		
Tiedown Fitting	4	0.067	0.268	3,731,343	20*		
Pintle Hook	1	0.737	0.737	1,356,852	149-95		
Frame Welded Control Panel	1	2.000	2.000	500,000			
Wheel	2	0.390	0.780	1,282,051	239-95		
Tire	2	14.960	29.920	33,422	218-95		
Housing-16 ga Steel	1	3.698	3.698	270,416	78*		
Fastener-1/4 Turn	12	6.542	78.504	12,738	59*		
Handle	4	0.067	0.268	3,731,343	20*		
Air Cycle Cooling Cart (#AM32C-10C)							
Failures per Million Hours of Usage =	**444**						
Mean Time Between Failures (MTBF) =	**2,252**						

Parts Description	**Parts Quantity**	**Failures per Million Hours**	**Qty x Fail per Million Hours**	**MTBF x Qty (Hours)**	**Reliability Source, Corr.**	**Weight (pounds)**	**Footprint (sq. ft.)**
Air Cycle Cooling Cart	1	2,299.000	2,299.000	435	Mil-Spec	1,325	34
Heat Exchanger	1	1.634	1.634	611,995	74*		
Plenum	12	1.032	12.384	80,749	77*		
Flexible Hose (ft)	4	1.032	4.128	242,248	77*		
Hose Clamp	24	0.074	1.776	563,063	23, 10X*		
Pressure Relief Valve	1	1.479	1.479	676,133	155*		
Ambient Air Filter	2	0.799	1.598	625,782	89, 10X*		
High Pressure Air Filter	1	0.839	0.839	1,191,895	91*		
Water Separator	1	3.295	3.295	303,490	123, 100/*		
Water Coalescer	1	3.295	3.295	303,490	123, 100/*		
Oil Lubricating Tank	1	2.567	2.567	389,560	143*		
Oil Drain Valve	1	1.438	1.438	695,410	152*		
Oil Level Sight Glass	1	7.364	7.364	135,796	65, 65*		
Primary Discharge Air Temp Gauge	1	1.959	1.959	510,465	66*		
Primary Discharge Air Temp Sensor	1	1.069	1.069	935,454	122, 10X*		
Primary Discharge Pressure Gauge	1	7.194	7.194	139,005	66*		
Primary Discharge Pressure Sensor	1	6.850	6.850	145,985	122*		
Primary Airflow Meter	1	9.549	9.549	104,723	93, 2X*		
HP Discharge Air Temp Gauge	1	1.959	1.959	510,465	66*		
HP Discharge Air Temp Sensor	1	1.069	1.069	935,454	122, 10X*		
HP Discharge Pressure Gauge	1	7.194	7.194	139,005	66*		
HP Discharge Pressure Sensor	1	6.850	6.850	145,985	122*		
HP Airflow Meter	1	9.549	9.549	104,723	93, 2X*		
Bleed Air Economy Control Valve	1	7.364	7.364	135,796	153*		
Air Volume Control Valve	1	7.364	7.364	135,796	153*		
Bypass Duct Shutoff Valve	1	1.438	1.438	695,410	152*		
Primary Air Duct	4	1.032	4.128	242,248	77*		
High Pressure Shutoff Valve	1	1.438	1.438	695,410	152*		

Frame and Axle Assembly	----	----	----	----	----	----	----
Frame	1	19.231	19.231	51,999	38*		
Axle	2	9.539	19.078	52,416	8*		
Spring-Leaf Type	4	35.912	143.648	6,961	127*		
Parking Brake	2	4.274	8.548	116,986	15*		
Brake Handle	1	35.587	35.587	28,100	131*		
Tiedown Fitting	4	0.067	0.268	3,731,343	20*		
Pintle Hook	1	0.737	0.737	1,356,852	149-95		
Frame Welded Control Panel	1	2.000	2.000	500,000			
Wheel	4	0.390	1.560	641,026	239-95		
Tire	4	14.960	59.840	16,711	218-95		
Housing-16 ga Steel	1	3.698	3.698	270,416	78*		
Handle	4	0.067	0.268	3,731,343	20*		
Flood Light Cart (#NF-2D)							
Failures per Million Hours of Usage =	**888**						
Mean Time Between Failures (MTBF) =	**1,126**						
Parts Description	**Parts Quantity**	**Failures per Million Hours**	**Qty x Fail per Million Hours**	**MTBF x Qty (Hours)**	**Reliability Source, Corr.**	**Weight (pounds)**	**Footprint (sq. ft.)**
Flood Light Cart	1	----	----	----	----	2,275	47
Flood Light	2	41.667	83.334	12,000	McMaster		
Scissor Hoist	1	10.000	10.000	100,000			
Diesel Engine-8 HP	1	167.969	167.969	5,953	55*		
Exhaust System	1	77.219	77.219	12,950	102, 94		
Fuel Tank	1	6.321	6.321	158,203	142*		
Generator-3 KW	1	18.868	18.868	53,000	70*		
Battery-12V Lead Acid	2	27.027	54.054	18,500	9*		
Switch On-Off	3	5.165	15.495	64,537	138*		
Circuit Breaker	2	3.649	7.298	137,024	21*		
Hourmeter	1	5.028	5.028	198,886	95, 95/100*		
Voltmeter Gauge	2	34.666	69.332	14,423	95*		
Ammeter Gauge	1	0.366	0.366	2,732,240	92*		
Frame and Axle Assembly	----	----	----	----	----	----	----
Frame	1	19.231	19.231	51,999	38*		
Axle	2	9.539	19.078	52,416	8*		
Spring-Leaf Type	4	35.912	143.648	6,961	127*		
Parking Brake	2	4.274	8.548	116,986	15*		
Brake Handle	1	35.587	35.587	28,100	131*		
Tiedown Fitting	4	0.067	0.268	3,731,343	20*		
Pintle Hook	1	0.737	0.737	1,356,852	149-95		
Frame Welded Control Panel	1	2.000	2.000	500,000			
Wheel	4	0.390	1.560	641,026	239-95		
Tire	4	14.960	59.840	16,711	218-95		
Housing-16 ga Steel	1	3.698	3.698	270,416	78*		
Fastener-1/4 Turn	12	6.542	78.504	12,738	59*		
Handle	4	0.067	0.268	3,731,343	20*		
Liquid Nitrogen Cart (#A0411000)							
Failures per Million Hours of Usage =	**758**						
Mean Time Between Failures (MTBF) =	**1,320**						
Parts Description	**Parts Quantity**	**Failures per Million Hours**	**Qty x Fail per Million Hours**	**MTBF x Qty (Hours)**	**Reliability Source, Corr.**	**Weight (pounds)**	**Footprint (sq. ft.)**
Liquid Nitrogen Cart	1	----	----	----	----	3,530	52
Dewar	1	10.000	10.000	100,000			
Cryogenic Pump	1	95.593	95.593	10,461	104*		
Heat Exchanger-Vaporizer	1	1.634	1.634	611,995	74*		
Pressure Gauge	10	1.020	10.200	98,039	66*		
Toggle Valve	5	1.336	6.680	149,701	154*		
Differential Pressure Gauge	1	1.030	1.030	970,874	66*		
Bleed Valve	10	7.364	73.640	13,580	153*		
Pressure Regulator	1	8.324	8.324	120,135	110*		
Pressure Relief Valve	1	1.479	1.479	676,133	155*		
Temperature Gauge	2	1.959	3.918	255,232	66*		

Brake Handle	1	35.587	35.587	28,100	131*		
Tiedown Fitting	4	0.067	0.268	3,731,343	20*		
Pintle Hook	1	0.737	0.737	1,356,852	149-95		
Frame Welded Control Panel	1	2.000	2.000	500,000			
Wheel	4	0.390	1.560	641,026	239-95		
Tire	4	14.960	59.840	16,711	218-95		
Housing-16 ga Steel	1	3.698	3.698	270,416	78*		
Fastener-1/4 Turn	16	6.542	104.672	9,554	59*		
Handle	4	0.067	0.268	3,731,343	20*		
Nitrogen Cylinder Cart (#NG-02)							
Failures per Million Hours of Usage =	**162**						
Mean Time Between Failures (MTBF) =	**6,161**						
Parts Description	**Parts Quantity**	**Failures per Million Hours**	**Qty x Fail per Million Hours**	**MTBF x Qty (Hours)**	**Reliability Source, Corr.**	**Weight (pounds)**	**Footprint (sq. ft.)**
Nitrogen Cylinder Cart	1	----	----	----	----	----	35
Nitrogen Cylinder	8	1.616	12.928	77,351	143*		
Manifold	1	7.217	7.217	138,562	88*		
Pressure Relief Valve	1	1.479	1.479	676,133	155*		
Pressure Regulator	1	8.324	8.324	120,135	110*		
Hose (ft)	30	1.032	30.960	32,300	77*		
Regulator Inlet Pressure Gauge	1	1.030	1.030	970,874	66*		
Regulator Outlet Pressure Gauge	1	1.030	1.030	970,874	66*		
Regulator Outlet Low Pressure Gauge	1	1.030	1.030	970,874	66*		
Air Filter	1	3.242	3.242	308,452	89*		
Manifold Shutoff Valve	1	1.336	1.336	748,503	154*		
Recharge Valve	1	7.364	7.364	135,796	153*		
Cylinder Pressure Gauge	8	1.030	8.240	121,359	66*		
Intermediate Control Valve	8	7.364	58.912	16,974	153*		
Frame and Axle Assembly	----	----	----	----	----	----	----
Frame	1	19.231	19.231	51,999	38*		
Axle	1	9.539	9.539	104,833	8*		
Spring-Leaf Type	2	35.912	71.824	13,923	127*		
Parking Brake	2	4.274	8.548	116,986	15*		
Brake Handle	1	35.587	35.587	28,100	131*		
Tiedown Fitting	4	0.067	0.268	3,731,343	20*		
Pintle Hook	1	0.737	0.737	1,356,852	149-95		
Frame Welded Control Panel	1	2.000	2.000	500,000			
Wheel	2	0.390	0.780	1,282,051	239-95		
Tire	2	14.960	29.920	33,422	218-95		

Appendix B: LCOM Database file

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 15
 15 C5         A   1   75KK  32
 15 KC10       A   1         24
 15 N2-MX      M        20K 900
 15 N2-MX1     M        20K 900
 15 N2-MX5     M        20K 900
 15 N2-SE      S        50K 900
 15 N2-SE-T    S        50K 900
 15 N2-SE-C    S        50K 900
 15 DUMMY      S        50K 900
 15 F13AA01    C                            278H    0.   X
 15 F13AE01    C                            877H    0.   X
 15 F13BA01    C                            977H    0.   X
 15 F13DAB1    C                            757H    0.   X
 15 F13DBB1    C                           1187H    0.   X
 15 F45ABH1    C                             77H    0.   X
 15 F46GJ01    C                            327H    0.   X
 15 F010001    C                             25H    0.   X
 15 F11LCH5    C                             17H    0.   X
 15 F11LCK5    C                             54H    0.   X
 15 F13AAA5    C                             85H    0.   X
 15 F13FCN5    C                             48H    0.   X
 15 F13LA05    C                             27H    0.   X
 15 F13LC05    C                             92H    0.   X
 15 F24ALP5    C                             56H    0.   X
 15 F91AAF5    C                             90H    0.   X
 15 F010005    C                             95H    0.   X
 15 FN2        C                             10H    0.   X
 25
 25 SORTIE 1              12
 25 SORTIE 5              12
 25 DECRMT1               22             C
 25 DECRMT2               22             C
 25 FIX-N2                21    1.0H  .29HL *DUMMY   N2-MX    1 N2-SE-C 1
N2-SE   1
 25 GT0                   52    0.0H     C
 25 GT1                   52    1.0H     C
 25 GT2                   52    2.0H     C
 25 GT4                   52    4.0H     C
 25 GT17                  52   17.0H     C
 25 GT24                  52   24.0H     C
 25 GT31                  52   31.0H     C
 25 GT33                  52   33.0H     C
 25 GT39                  52   39.0H     C
 25 GT47                  52   47.0H     C
 25 GT51                  52   51.0H     C
 25 C5FURB                33   100.H   29.HN
 25 C5HSC                 33   50.0H 14.5HN
 25 C5ISO                 33   50.0H 14.5HN
 25 C5WASH                33   10.0H  2.9HN
 25 KC10A1CK              33   20.0H  5.8HN
 25 KC10A2CK              33   20.0H  5.8HN
 25 KC10C-CK              33   20.0H  5.8HN
 25 KC10FURB              33   100.H   29.HN
```

25	PSTFLT1	32	2.00H	.58HN		N2-MX1	1		
25	PSTFLT5	32	2.00H	.58HN		N2-MX5	1		
25	PREFLT-1	32	0.50H	.15HN		N2-MX1	1		
25	PREFLT-5	32	0.50H	.15HN		N2-MX5	1		
25	QN2-SE	23				N2-SE	C1		
25	GN2-SE	32			*N2-SE				
25	DELAY-UNSCH-10	23	*299			N2-SE-T	1		
25	DELAY-SCHED-10	33	*299			N2-SE-T	1		
25	USE-N2-PF1	22	0.88H	.26HL		N2-MX1	1	N2-SE-T	1
25	USE-N2-PF5	22	0.88H	.26HL		N2-MX5	1	N2-SE-T	1
25	USE-N2-PRF1	22	0.77H	.22HL		N2-MX1	1	N2-SE-T	1
25	USE-N2-PRF5	22	0.77H	.22HL		N2-MX5	1	N2-SE-T	1
25	USE-N2-13AA01	23	1.12H	.32HL		N2-MX1	1	N2-SE-T	1
25	USE-N2-13AE01	23	1.12H	.32HL		N2-MX1	1	N2-SE-T	1
25	USE-N2-13BA01	23	1.12H	.32HL		N2-MX1	1	N2-SE-T	1
25	USE-N2-13DAB1	23	0.35H	.10HL		N2-MX1	1	N2-SE-T	1
25	USE-N2-13DBB1	23	0.35H	.10HL		N2-MX1	1	N2-SE-T	1
25	USE-N2-45ABH1	23	0.87H	.25HL		N2-MX1	1	N2-SE-T	1
25	USE-N2-46GJ01	23	1.25H	.36HL		N2-MX1	1	N2-SE-T	1
25	USE-N2-010001	23	0.88H	.26HL		N2-MX1	1	N2-SE-T	1
25	USE-N2-11LCH5	23	0.88H	.26HL		N2-MX5	1	N2-SE-T	1
25	USE-N2-11LCK5	23	0.88H	.26HL		N2-MX5	1	N2-SE-T	1
25	USE-N2-13AAA5	23	0.75H	.22HL		N2-MX5	1	N2-SE-T	1
25	USE-N2-13FCN5	23	0.75H	.22HL		N2-MX5	1	N2-SE-T	1
25	USE-N2-13LA05	23	0.35H	.10HL		N2-MX5	1	N2-SE-T	1
25	USE-N2-13LC05	23	0.35H	.10HL		N2-MX5	1	N2-SE-T	1
25	USE-N2-24ALP5	23	0.88H	.26HL		N2-MX5	1	N2-SE-T	1
25	USE-N2-91AAF5	23	1.35H	.39HL		N2-MX5	1	N2-SE-T	1
25	USE-N2-010005	23	0.88H	.26HL		N2-MX5	1	N2-SE-T	1
25	M13AA01	23	1.12H	.32HL		N2-MX1	1		
25	S13AA01	23	0.0H	0.0HC		N2-MX1	1		
25	M13AE01	23	1.12H	.32HL		N2-MX1	1		
25	S13AE01	23	0.0H	0.0HC		N2-MX1	1		
25	M13BA01	23	1.12H	.32HL		N2-MX1	1		
25	S13BA01	23	0.0H	0.0HC		N2-MX1	1		
25	M13DAB1	23	2.75H	.80HL		N2-MX1	1		
25	S13DAB1	23	2.23H	.65HL		N2-MX1	1		
25	M13DBB1	23	2.75H	.80HL		N2-MX1	1		
25	S13DBB1	23	2.23H	.65HL		N2-MX1	1		
25	M45ABH1	23	0.87H	.25HL		N2-MX1	1		
25	S45ABH1	23	0.0H	0.0HC		N2-MX1	1		
25	M46GJ01	23	1.25H	.36HL		N2-MX1	1		
25	S46GJ01	23	0.0H	0.0HC		N2-MX1	1		
25	M010001	23	0.88H	.26HL		N2-MX1	1		
25	S010001	23	0.0H	0.0HC		N2-MX1	1		
25	M11LCH5	23	2.80H	.81HL		N2-MX5	1		
25	S11LCH5	23	1.75H	.51HL		N2-MX5	1		
25	M11LCK5	23	2.80H	.81HL		N2-MX5	1		
25	S11LCK5	23	1.75H	.51HL		N2-MX5	1		
25	M13AAA5	23	2.80H	.81HL		N2-MX5	1		
25	S13AAA5	23	1.88H	.55HL		N2-MX5	1		
25	M13FCN5	23	2.70H	.78HL		N2-MX5	1		
25	S13FCN5	23	1.78H	.52HL		N2-MX5	1		
25	M13LA05	23	2.00H	.58HL		N2-MX5	1		
25	S13LA05	23	1.48H	.43HL		N2-MX5	1		
25	M13LC05	23	2.00H	.58HL		N2-MX5	1		
25	S13LC05	23	1.48H	.43HL		N2-MX5	1		

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25 M24ALP5             23  3.95H 1.15HL          N2-MX5  1
25 S24ALP5             23  2.9H   .84HL          N2-MX5  1
25 M91AAF5             23  1.35H  .39HL          N2-MX5  1
25 S91AAF5             23  0.0H   0.0HC          N2-MX5  1
25 M010005             23  0.0H   0.0HC          N2-MX5  1
25 S010005             23  0.0H   0.0HC          N2-MX5  1
30
30 CHANA    PREFLT5              CHANA1*  C
30 CHANA1*  DECRMT1              CHANA1A  D
30 CHANA1A  UNSCH5               CHANA1   C
30 CHANA1   SORTIE 5             CHANA2*  S
30 CHANA2*  DECRMT2              CHANA2   D
30 CHANA2   GT47                 CHANA3   D
30 CHANA3   PSTFLT5                       C
30 CHANA3   UNSCH5                        C
30 CHANB    PREFLT5              CHANB1*  C
30 CHANB1*  DECRMT1              CHANB1A  D
30 CHANB1A  UNSCH5               CHANB1   C
30 CHANB1   SORTIE 5             CHANB2*  S
30 CHANB2*  DECRMT2              CHANB2   D
30 CHANB2   GT31                 CHANB3   D
30 CHANB3   PSTFLT5                       C
30 CHANB3   UNSCH5                        C
30 CHANC    PREFLT5              CHANC1*  C
30 CHANC1*  DECRMT1              CHANC1A  D
30 CHANC1A  UNSCH5               CHANC1   C
30 CHANC1   SORTIE 5             CHANC2*  S
30 CHANC2*  DECRMT2              CHANC2   D
30 CHANC2   GT51                 CHANC3   D
30 CHANC3   PSTFLT5                       C
30 CHANC3   UNSCH5                        C
30 SAM21    PREFLT5              SAM211*  C
30 SAM211*  DECRMT1              SAM211A  D
30 SAM211A  UNSCH5               SAM211   C
30 SAM211   SORTIE 5             SAM212*  S
30 SAM212*  DECRMT2              SAM212   D
30 SAM212   GT24                 SAM213   D
30 SAM213   PSTFLT5                       C
30 SAM213   UNSCH5                        C
30 SAM22    PREFLT5              SAM221*  C
30 SAM221*  DECRMT1              SAM221A  D
30 SAM221A  UNSCH5               SAM221   C
30 SAM221   SORTIE 5             SAM222*  S
30 SAM222*  DECRMT2              SAM222   D
30 SAM222   GT24                 SAM223   D
30 SAM223   PSTFLT5                       C
30 SAM223   UNSCH5                        C
30 JAATT    PREFLT5              JAATT1*  C
30 JAATT1*  DECRMT1              JAATT1A  D
30 JAATT1A  UNSCH5               JAATT1   C
30 JAATT1   SORTIE 5             JAATT2*  S
30 JAATT2*  DECRMT2              JAATT2   D
30 JAATT2   GT4                  JAATT3   D
30 JAATT3   PSTFLT5                       C
30 JAATT3   UNSCH5                        C
30 EXERC    PREFLT5               EXERC1* C
30 EXERC1*  DECRMT1               EXERC1A D
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30	EXERC1A	UNSCH5	EXERC1	C	
30	EXERC1	SORTIE 5	EXERC2*	S	
30	EXERC2*	DECRMT2	EXERC2	D	
30	EXERC2	GT17	EXERC3	D	
30	EXERC3	PSTFLT5		C	
30	EXERC3	UNSCH5		C	
30	TNGA	PREFLT5	TNGA1*	C	
30	TNGA1*	DECRMT1	TNGA1A	D	
30	TNGA1A	UNSCH5	TNGA1	C	
30	TNGA1	SORTIE 5	TNGA2*	S	
30	TNGA2*	DECRMT2	TNGA2	D	
30	TNGA2	GT2	TNGA3	D	
30	TNGA3	PSTFLT5		C	
30	TNGA3	UNSCH5		C	
30	TNGB	PREFLT5	TNGB1*	C	
30	TNGB1*	DECRMT1	TNGB1A	D	
30	TNGB1A	UNSCH5	TNGB1	C	
30	TNGB1	SORTIE 5	TNGB2*	S	
30	TNGB2*	DECRMT2	TNGB2	D	
30	TNGB2	GT0	TNGB3	D	
30	TNGB3	PSTFLT5		C	
30	TNGB3	UNSCH5		C	
30	PSTFLT5			E	.50
30	PSTFLT5	PSTFLT5	PSTFLT52	E	.50
30	PSTFLT52	QN2-SE	PSTFLT53	D	
30	PSTFLT53	DELAY-SCHED-10	PSTFLT54	D	
30	PSTFLT54	USE-N2-PF5	PSTFLT55	D	
30	PSTFLT55	GN2-SE		D	
30	PSTFLT55	CART		C	
30	KEXER	PREFLT1	KEXER1*	C	
30	KEXER1*	DECRMT1	KEXER1A	D	
30	KEXER1A	UNSCH1	KEXER1	C	
30	KEXER1	SORTIE 1	KEXER2*	S	
30	KEXER2*	DECRMT2	KEXER2	D	
30	KEXER2	GT24	KEXER3	D	
30	KEXER3	PSTFLT1		C	
30	KEXER3	UNSCH1		C	
30	KCHAN	PREFLT1	KCHAN1*	C	
30	KCHAN1*	DECRMT1	KCHAN1A	D	
30	KCHAN1A	UNSCH1	KCHAN1	C	
30	KCHAN1	SORTIE 1	KCHAN2*	S	
30	KCHAN2*	DECRMT2	KCHAN2	D	
30	KCHAN2	GT39	KCHAN3	D	
30	KCHAN3	PSTFLT1		C	
30	KCHAN3	UNSCH1		C	
30	KSAAM	PREFLT1	KSAAM1*	C	
30	KSAAM1*	DECRMT1	KSAAM1A	D	
30	KSAAM1A	UNSCH1	KSAAM1	C	
30	KSAAM1	SORTIE 1	KSAAM2*	S	
30	KSAAM2*	DECRMT2	KSAAM2	D	
30	KSAAM2	GT33	KSAAM3	D	
30	KSAAM3	PSTFLT1		C	
30	KSAAM3	UNSCH1		C	
30	KJAAT	PREFLT1	KJAAT1*	C	
30	KJAAT1*	DECRMT1	KJAAT1A	D	
30	KJAAT1A	UNSCH1	KJAAT1	C	
30	KJAAT1	SORTIE 1	KJAAT2*	S	

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30 KJAAT2*   DECRMT2             KJAAT2    D
30 KJAAT2    GT4                 KJAAT3    D
30 KJAAT3    PSTFLT1                       C
30 KJAAT3    UNSCH1                        C
30 KTNGA     PREFLT1             KTNGA1*   C
30 KTNGA1*   DECRMT1             KTNGA1A   D
30 KTNGA1A   UNSCH1              KTNGA1    C
30 KTNGA1    SORTIE 1            KTNGA2*   S
30 KTNGA2*   DECRMT2             KTNGA2    D
30 KTNGA2    GT1                 KTNGA3    D
30 KTNGA3    PSTFLT1                       C
30 KTNGA3    UNSCH1                        C
30 PSTFLT1                                 E .50
30 PSTFLT1   PSTFLT1             PSTFLT12  E .50
30 PSTFLT12  QN2-SE              PSTFLT13  D
30 PSTFLT13  DELAY-SCHED-10      PSTFLT14  D
30 PSTFLT14  USE-N2-PF1          PSTFLT15  D
30 PSTFLT15  GN2-SE                        D
30 PSTFLT15  CART                          C
30 UNSCH5                        UNSCH51   FF11LCH5
30 UNSCH51   M11LCH5                       E .10
30 UNSCH51   S11LCH5             UNSCH512  E .90
30 UNSCH512  QN2-SE              UNSCH513  D
30 UNSCH513  DELAY-UNSCH-10      UNSCH514  D
30 UNSCH514  USE-N2-11LCH5       UNSCH515  D
30 UNSCH515  GN2-SE                        D
30 UNSCH515  CART                          C
30 UNSCH5                        UNSCH52   FF11LCK5
30 UNSCH52   M11LCK5                       E .10
30 UNSCH52   S11LCK5             UNSCH522  E .90
30 UNSCH522  QN2-SE              UNSCH523  D
30 UNSCH523  DELAY-UNSCH-10      UNSCH524  D
30 UNSCH524  USE-N2-11LCK5       UNSCH525  D
30 UNSCH525  GN2-SE                        D
30 UNSCH525  CART                          C
30 UNSCH5                        UNSCH53   FF13AAA5
30 UNSCH53   M13AAA5                       E .10
30 UNSCH53   S13AAA5             UNSCH532  E .90
30 UNSCH532  QN2-SE              UNSCH533  D
30 UNSCH533  DELAY-UNSCH-10      UNSCH534  D
30 UNSCH534  USE-N2-13AAA5       UNSCH535  D
30 UNSCH535  GN2-SE                        D
30 UNSCH535  CART                          C
30 UNSCH5                        UNSCH54   FF13FCN5
30 UNSCH54   M13FCN5                       E .10
30 UNSCH54   S13FCN5             UNSCH542  E .90
30 UNSCH542  QN2-SE              UNSCH543  D
30 UNSCH543  DELAY-UNSCH-10      UNSCH544  D
30 UNSCH544  USE-N2-13FCN5       UNSCH545  D
30 UNSCH545  GN2-SE                        D
30 UNSCH545  CART                          C
30 UNSCH5                        UNSCH55   FF13LA05
30 UNSCH55   M13LA05                       E .10
30 UNSCH55   S13LA05             UNSCH552  E .90
30 UNSCH552  QN2-SE              UNSCH553  D
30 UNSCH553  DELAY-UNSCH-10      UNSCH554  D
30 UNSCH554  USE-N2-13LA05       UNSCH555  D
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30 UNSCH555 GN2-SE                       D
30 UNSCH555 CART                         C
30 UNSCH5                       UNSCH56  FF13LC05
30 UNSCH56  M13LC05                      E .10
30 UNSCH56  S13LC05             UNSCH562 E .90
30 UNSCH562 QN2-SE              UNSCH563 D
30 UNSCH563 DELAY-UNSCH-10      UNSCH564 D
30 UNSCH564 USE-N2-13LC05       UNSCH565 D
30 UNSCH565 GN2-SE                       D
30 UNSCH565 CART                         C
30 UNSCH5                       UNSCH57  FF24ALP5
30 UNSCH57  M24ALP5                      E .10
30 UNSCH57  S24ALP5             UNSCH572 E .90
30 UNSCH572 QN2-SE              UNSCH573 D
30 UNSCH573 DELAY-UNSCH-10      UNSCH574 D
30 UNSCH574 USE-N2-24ALP5       UNSCH575 D
30 UNSCH575 GN2-SE                       D
30 UNSCH575 CART                         C
30 UNSCH5                       UNSCH58  FF91AAF5
30 UNSCH58  M91AAF5                      E .10
30 UNSCH58  S91AAF5             UNSCH582 E .90
30 UNSCH582 QN2-SE              UNSCH583 D
30 UNSCH583 DELAY-UNSCH-10      UNSCH584 D
30 UNSCH584 USE-N2-91AAF5       UNSCH585 D
30 UNSCH585 GN2-SE                       D
30 UNSCH585 CART                         C
30 UNSCH5                       UNSCH59  FF010005
30 UNSCH59  M010005                      E .10
30 UNSCH59  S010005             UNSCH592 E .90
30 UNSCH592 QN2-SE              UNSCH593 D
30 UNSCH593 DELAY-UNSCH-10      UNSCH594 D
30 UNSCH594 USE-N2-010005       UNSCH595 D
30 UNSCH595 GN2-SE                       D
30 UNSCH595 CART                         C
30 UNSCH1                       UNSCH11  FF13AA01
30 UNSCH11  M13AA01                      E .10
30 UNSCH11  S13AA01             UNSCH112 E .90
30 UNSCH112 QN2-SE              UNSCH113 D
30 UNSCH113 DELAY-UNSCH-10      UNSCH114 D
30 UNSCH114 USE-N2-13AA01       UNSCH115 D
30 UNSCH115 GN2-SE                       D
30 UNSCH115 CART                         C
30 UNSCH1                       UNSCH12  FF13AE01
30 UNSCH12  M13AE01                      E .10
30 UNSCH12  S13AE01             UNSCH122 E .90
30 UNSCH122 QN2-SE              UNSCH123 D
30 UNSCH123 DELAY-UNSCH-10      UNSCH124 D
30 UNSCH124 USE-N2-13AE01       UNSCH125 D
30 UNSCH125 GN2-SE                       D
30 UNSCH125 CART                         C
30 UNSCH1                       UNSCH13  FF13BA01
30 UNSCH13  M13BA01                      E .10
30 UNSCH13  S13BA01             UNSCH132 E .90
30 UNSCH132 QN2-SE              UNSCH133 D
30 UNSCH133 DELAY-UNSCH-10      UNSCH134 D
30 UNSCH134 USE-N2-13BA01       UNSCH135 D
30 UNSCH135 GN2-SE                       D
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30 UNSCH135 CART                         C
30 UNSCH1                      UNSCH14   FF13DAB1
30 UNSCH14  M13DAB1                      E .10
30 UNSCH14  S13DAB1            UNSCH142  E .90
30 UNSCH142 QN2-SE             UNSCH143  D
30 UNSCH143 DELAY-UNSCH-10     UNSCH144  D
30 UNSCH144 USE-N2-13DAB1      UNSCH145  D
30 UNSCH145 GN2-SE                       D
30 UNSCH145 CART                         C
30 UNSCH1                      UNSCH15   FF13DBB1
30 UNSCH15  M13DBB1                      E .10
30 UNSCH15  S13DBB1            UNSCH152  E .90
30 UNSCH152 QN2-SE             UNSCH153  D
30 UNSCH153 DELAY-UNSCH-10     UNSCH154  D
30 UNSCH154 USE-N2-13DBB1      UNSCH155  D
30 UNSCH155 GN2-SE                       D
30 UNSCH155 CART                         C
30 UNSCH1                      UNSCH16   FF45ABH1
30 UNSCH16  M45ABH1                      E .10
30 UNSCH16  S45ABH1            UNSCH162  E .90
30 UNSCH162 QN2-SE             UNSCH163  D
30 UNSCH163 DELAY-UNSCH-10     UNSCH164  D
30 UNSCH164 USE-N2-45ABH1      UNSCH165  D
30 UNSCH165 GN2-SE                       D
30 UNSCH165 CART                         C
30 UNSCH1                      UNSCH17   FF46GJ01
30 UNSCH17  M46GJ01                      E .10
30 UNSCH17  S46GJ01            UNSCH172  E .90
30 UNSCH172 QN2-SE             UNSCH173  D
30 UNSCH173 DELAY-UNSCH-10     UNSCH174  D
30 UNSCH174 USE-N2-46GJ01      UNSCH175  D
30 UNSCH175 GN2-SE                       D
30 UNSCH175 CART                         C
30 UNSCH1                      UNSCH18   FF010001
30 UNSCH18  M010001                      E .50
30 UNSCH18  S010001            UNSCH182  E .50
30 UNSCH182 QN2-SE             UNSCH183  D
30 UNSCH183 DELAY-UNSCH-10     UNSCH184  D
30 UNSCH184 USE-N2-010001      UNSCH185  D
30 UNSCH185 GN2-SE                       D
30 UNSCH185 CART                         C
30 CART                        CART2     FFN2
30 CART2    FIX-N2                       D
30 PREFLT1                               E .50
30 PREFLT1  PREFLT-1           PREFLT12  E .50
30 PREFLT12 QN2-SE             PREFLT13  D
30 PREFLT13 DELAY-SCHED-10     PREFLT14  D
30 PREFLT14 USE-N2-PRF1        PREFLT15  D
30 PREFLT15 GN2-SE                       D
30 PREFLT15 CART                         C
30 PREFLT5                               E .50
30 PREFLT5  PREFLT-5           PREFLT52  E .50
30 PREFLT52 QN2-SE             PREFLT53  D
30 PREFLT53 DELAY-SCHED-10     PREFLT54  D
30 PREFLT54 USE-N2-PRF5        PREFLT55  D
30 PREFLT55 GN2-SE                       D
30 PREFLT55 CART                         C
```

```
30 C5FURB   C5FURB                                  D
30 C5HSC    C5HSC                                   D
30 C5ISO    C5ISO                                   D
30 C5WASH   C5WASH                                  D
30 KC10A1CK KC10A1CK                                D
30 KC10A2CK KC10A2CK                                D
30 KC10C-CK KC10C-CK                                D
30 KC10FURB KC10FURB                                D
35
35 DECRMT1                 C F13AA01   .05
35                         C F13AE01   .05
35                         C F13BA01   .05
35                         C F13DAB1   .05
35                         C F13DBB1   .05
35                         C F45ABH1   .05
35                         C F46GJ01   .05
35                         C F010001   .05
35                         C F11LCH5   .05
35                         C F11LCK5   .05
35                         C F13AAA5   .05
35                         C F13FCN5   .05
35                         C F13LA05   .05
35                         C F13LC05   .05
35                         C F24ALP5   .05
35                         C F91AAF5   .05
35                         C F010005   .05
35 DECRMT2                 C F13AA01   .95
35                         C F13AE01   .95
35                         C F13BA01   .95
35                         C F13DAB1   .95
35                         C F13DBB1   .95
35                         C F45ABH1   .95
35                         C F46GJ01   .95
35                         C F010001   .95
35                         C F11LCH5   .95
35                         C F11LCK5   .95
35                         C F13AAA5   .95
35                         C F13FCN5   .95
35                         C F13LA05   .95
35                         C F13LC05   .95
35                         C F24ALP5   .95
35                         C F91AAF5   .95
35                         C F010005   .95
35 USE-N2-13AA01           S FN2
35 USE-N2-13AE01           S FN2
35 USE-N2-13BA01           S FN2
35 USE-N2-13DAB1           S FN2
35 USE-N2-13DBB1           S FN2
35 USE-N2-45ABH1           S FN2
35 USE-N2-46GJ01           S FN2
35 USE-N2-010001           S FN2
35 USE-N2-11LCH5           S FN2
35 USE-N2-11LCK5           S FN2
35 USE-N2-13AAA5           S FN2
35 USE-N2-13FCN5           S FN2
35 USE-N2-13LA05           S FN2
35 USE-N2-13LC05           S FN2
```

```
 35 USE-N2-24ALP5       S FN2
 35 USE-N2-91AAF5       S FN2
 35 USE-N2-010005       S FN2
 45
 45 *             8   8   8
 45 R                     7
 45   N2-MX      999 999 999
 45   N2-MX1     999 999 999
 45   N2-MX5     999 999 999
X   MSN NAME        NODE      PRE       POST      SEARCH    A/C
 55
 55 CHNLA           CHANA     NORMAL    NORMAL    C5        C5
 55 CHNLB           CHANB     NORMAL    NORMAL    C5        C5
 55 CHNLC           CHANC     NORMAL    NORMAL    C5        C5
 55 SAM21           SAM21     NORMAL    NORMAL    C5        C5
 55 SAM22           SAM22     NORMAL    NORMAL    C5        C5
 55 JAATT           JAATT     NORMAL    NORMAL    C5        C5
 55 EXERC           EXERC     NORMAL    NORMAL    C5        C5
 55 TRNGA           TNGA      NORMAL    NORMAL    C5        C5
 55 TRNGB           TNGB      NORMAL    NORMAL    C5        C5
 55 KEXER           KEXER     NORMAL    NORMAL    KC10      KC10
 55 KCHAN           KCHAN     NORMAL    NORMAL    KC10      KC10
 55 KSAAM           KSAAM     NORMAL    NORMAL    KC10      KC10
 55 KJAAT           KJAAT     NORMAL    NORMAL    KC10      KC10
 55 KTNGA           KTNGA     NORMAL    NORMAL    KC10      KC10
 55 FUR1B         A C5FURB                        C5        C5
 55 HSC4          A C5HSC                         C5        C5
 55 IS04          A C5ISO                         C5        C5
 55 A1CHK         A KC10A1CK                      KC10      KC10
 55 A2CHK         A KC10A2CK                      KC10      KC10
 55 CCHEK         A KC10C-CK                      KC10      KC10
 55 RFURB         A KC10FURB                      KC10      KC10
 60
 60 C5          C NORMAL                                   0.0
 60 C5        C A NORMAL                                   0.0
 60 KC10        C NORMAL                                   0.0
 60 KC10      C A NORMAL                                   0.0
```

Appendix C: LCOM Form 75s (Peacetime)

```
40
 40    1 S   .99       1 1.0     0
 40    2 S   .98       1 1.0     0
 40    3 S   .97       1 1.0     0
 40    4 S   .96       1 1.0     0
 40    5 S   .95       1 1.0     0
 40    6 S   .94       1 1.0     0
 40    7 S   .93       1 1.0     0
 40    8 S   .92       1 1.0     0
 40    9 S   .91       1 1.0     0
 40   10 S   .90       1 1.0     0
 40   11 S   .89       1 1.0     0
 40   12 S   .88       1 1.0     0
 40   13 S   .87       1 1.0     0
 40   14 S   .86       1 1.0     0
 40   15 S   .85       1 1.0     0
 40   16 S   .84       1 1.0     0
 40   17 S   .83       1 1.0     0
 40   18 S   .82       1 1.0     0
 40   19 S   .81       1 1.0     0
 40   20 S   .80       1 1.0     0
 40   21 S   .79       1 1.0     0
 40   22 S   .78       1 1.0     0
 40   23 S   .77       1 1.0     0
 40   24 S   .76       1 1.0     0
 40   25 S   .75       1 1.0     0
 40   26 S   .74       1 1.0     0
 40   27 S   .73       1 1.0     0
 40   28 S   .72       1 1.0     0
 40   29 S   .71       1 1.0     0
 40   30 S   .70       1 1.0     0
 40   31 S   .69       1 1.0     0
 40   32 S   .68       1 1.0     0
 40   33 S   .67       1 1.0     0
 40   34 S   .66       1 1.0     0
 40   35 S   .65       1 1.0     0
 40   36 S   .64       1 1.0     0
 40   37 S   .63       1 1.0     0
 40   38 S   .62       1 1.0     0
 40   39 S   .61       1 1.0     0
 40   40 S   .60       1 1.0     0
 40   41 S   .59       1 1.0     0
 40   42 S   .58       1 1.0     0
 40   43 S   .57       1 1.0     0
 40   44 S   .56       1 1.0     0
 40   45 S   .55       1 1.0     0
 40   46 S   .54       1 1.0     0
 40   47 S   .53       1 1.0     0
 40   48 S   .52       1 1.0     0
 40   49 S   .51       1 1.0     0
 40   50 S   .50       1 1.0     0
 40   51 S   .49       1 1.0     0
 40   52 S   .48       1 1.0     0
 40   53 S   .47       1 1.0     0
 40   54 S   .46       1 1.0     0
 40   55 S   .45       1 1.0     0
 40   56 S   .44       1 1.0     0
 40   57 S   .43       1 1.0     0
 40   58 S   .42       1 1.0     0
 40   59 S   .41       1 1.0     0
```

```
40  60 S   .40      1 1.0     0
40  61 S   .39      1 1.0     0
40  62 S   .38      1 1.0     0
40  63 S   .37      1 1.0     0
40  64 S   .36      1 1.0     0
40  65 S   .35      1 1.0     0
40  66 S   .34      1 1.0     0
40  67 S   .33      1 1.0     0
40  68 S   .32      1 1.0     0
40  69 S   .31      1 1.0     0
40  70 S   .30      1 1.0     0
40  71 S   .29      1 1.0     0
40  72 S   .28      1 1.0     0
40  73 S   .27      1 1.0     0
40  74 S   .26      1 1.0     0
40  75 S   .25      1 1.0     0
40  76 S   .24      1 1.0     0
40  77 S   .23      1 1.0     0
40  78 S   .22      1 1.0     0
40  79 S   .21      1 1.0     0
40  80 S   .20      1 1.0     0
40  81 S   .19      1 1.0     0
40  82 S   .18      1 1.0     0
40  83 S   .17      1 1.0     0
40  84 S   .16      1 1.0     0
40  85 S   .15      1 1.0     0
40  86 S   .14      1 1.0     0
40  87 S   .13      1 1.0     0
40  88 S   .12      1 1.0     0
40  89 S   .11      1 1.0     0
40  90 S   .10      1 1.0     0
40  91 S   .09      1 1.0     0
40  92 S   .08      1 1.0     0
40  93 S   .07      1 1.0     0
40  94 S   .06      1 1.0     0
40  95 S   .05      1 1.0     0
40  96 S   .04      1 1.0     0
40  97 S   .03      1 1.0     0
40  98 S   .02      1 1.0     0
40  99 S   .01      1 1.0     0
40 101 I H 0.0  0.0  1.0 23.99
40 102 I H 0.0  6.5   .38 9.5   .3812.0   .58 14.0 .58 16.0
40 102 I H 0.9118.0  1.00 6.49
40 103 I H 0.0  6.5   .47 9.5   .4712.0   .80 14.0 .80 16.0
40 103 I H 0.9318.0  1.00 6.49
40 299 I M 0.0 5.0   0.8 10.0   0.2 20.0

75
75   1   *32 *101 C5       EXERC    1 1    0 13.2H 1.3H N 8.H 15M2  19999
75   1    *1 *101 KC10     KEXER    1 1    0 18.4H 1.8H N 8.H 15M2  19999
75   1   *21 *101 C5       CHNLA    1 1    0 26.7H 2.7H N 8.H 15M2  19999
75   1   *33 *101 KC10     KCHAN    1 1    0 24.2H 2.4H N 8.H 15M2  19999
75   1   *31 *101 C5       CHNLB    1 1    0 21.5H 2.1H N 8.H 15M2  19999
75   1   *39 *101 C5       CHNLC    1 1    0 29.9H 2.9H N 8.H 15M2  19999
75   1   *50 *101 C5       SAM22    1 1    0 17.0H 1.7H N 8.H 15M2  19999
75   1   *15 *101 KC10     KSAAM    1 1    0 17.6H 1.7H N 8.H 15M2  19999
75   1   *48 *101 C5       SAM21    1 1    0 16.8H 1.7H N 8.H 15M2  19999
75   1    *7 *101 C5       JAATT    1 1    0 7.20H .72H N 8.H 15M2  19999
75   1   *18 *101 KC10     KJAAT    1 1    0 6.30H .63H N 8.H 15M2  19999
75   8     1 *102 C5       TRNGA    1 1    0 4.00H 1.0H N 8.H 15M2  79999
75   8    10 *102 KC10     KTNGA    1 1    0 6.80H 1.0H N 8.H 15M2  79999
75   8   *30 *102 KC10     KTNGA    1 1    0 6.80H 1.0H N 8.H 15M2  79999
75   8   *24 *102 C5       TRNGA    1 1    0 4.00H 1.0H N 8.H 15M2  79999
```

75	8	2	*102	C5	TRNGB	1	1	1	9.10H	1.1H	N	8.H	15M2		79999
75	8	*15	*102	C5	TRNGB	1	1	1	9.10H	1.1H	N	8.H	15M2		79999
75	9	1	*102	C5	TRNGA	1	1	0	4.00H	1.0H	N	8.H	15M2		79999
75	9	*24	*102	C5	TRNGA	1	1	0	4.00H	1.0H	N	8.H	15M2		79999
75	9	10	*102	KC10	KTNGA	1	1	0	6.80H	1.0H	N	8.H	15M2		79999
75	9	*30	*102	KC10	KTNGA	1	1	0	6.80H	1.0H	N	8.H	15M2		79999
75	9	2	*102	C5	TRNGB	1	1	1	9.10H	1.1H	N	8.H	15M2		79999
75	9	*15	*102	C5	TRNGB	1	1	1	9.10H	1.1H	N	8.H	15M2		79999
75	9	1	0700	C5	FUR1B	1	1	0							289999
75	9	*42	0700	C5	HSC4	1	1	0							19999
75	9	1	0700	C5	IS04	1	1	0							119999
75	9	1	0700	KC10	A1CHK	1	1	0							119999
75	9	1	0700	KC10	A2CHK	1	1	0							119999
75	9	1	0700	KC10	CCHEK	1	1	0							119999
75	9	1	0700	KC10	RFURB	1	1	0							319999
75	10	2	*102	C5	TRNGB	1	1	1	9.10H	1.1H	N	8.H	15M2		79999
75	10	*15	*102	C5	TRNGB	1	1	1	9.10H	1.1H	N	8.H	15M2		79999
75	10	1	*102	C5	TRNGA	1	1	0	4.00H	1.0H	N	8.H	15M2		79999
75	10	*24	*102	C5	TRNGA	1	1	0	4.00H	1.0H	N	8.H	15M2		79999
75	10	10	*102	KC10	KTNGA	1	1	0	6.80H	1.0H	N	8.H	15M2		79999
75	10	*30	*102	KC10	KTNGA	1	1	0	6.80H	1.0H	N	8.H	15M2		79999
75	11	2	*102	C5	TRNGB	1	1	1	9.10H	1.1H	N	8.H	15M2		79999
75	11	*15	*102	C5	TRNGB	1	1	1	9.10H	1.1H	N	8.H	15M2		79999
75	11	1	*102	C5	TRNGA	1	1	0	4.00H	1.0H	N	8.H	15M2		79999
75	11	*24	*102	C5	TRNGA	1	1	0	4.00H	1.0H	N	8.H	15M2		79999
75	11	10	*102	KC10	KTNGA	1	1	0	6.80H	1.0H	N	8.H	15M2		79999
75	11	*30	*102	KC10	KTNGA	1	1	0	6.80H	1.0H	N	8.H	15M2		79999
75	12	2	*102	C5	TRNGB	1	1	1	9.10H	1.1H	N	8.H	15M2		79999
75	12	*15	*102	C5	TRNGB	1	1	1	9.10H	1.1H	N	8.H	15M2		79999
75	12	1	*102	C5	TRNGA	1	1	0	4.00H	1.0H	N	8.H	15M2		79999
75	12	*24	*102	C5	TRNGA	1	1	0	4.00H	1.0H	N	8.H	15M2		79999
75	12	10	*102	KC10	KTNGA	1	1	0	6.80H	1.0H	N	8.H	15M2		79999
75	12	*30	*102	KC10	KTNGA	1	1	0	6.80H	1.0H	N	8.H	15M2		79999
75	13	1	*102	KC10	KTNGA	1	1	0	6.80H	1.0H	N	8.H	15M2		79999
75	13	*46	*102	KC10	KTNGA	1	1	0	6.80H	1.0H	N	8.H	15M2		79999
75	13	*83	*103	C5	TRNGB	1	1	1	9.10H	1.1H	N	8.H	15M2		79999
75	13	*48	*103	C5	TRNGA	1	1	0	4.00H	1.0H	N	8.H	15M2		79999
75	14	*83	*103	C5	TRNGB	1	1	1	9.10H	1.1H	N	8.H	15M2		79999
75	14	*48	*103	C5	TRNGA	1	1	0	4.00H	1.0H	N	8.H	15M2		79999
75	14	1	*102	KC10	KTNGA	1	1	0	6.80H	1.0H	N	8.H	15M2		79999
75	14	*46	*102	KC10	KTNGA	1	1	0	6.80H	1.0H	N	8.H	15M2		79999

Appendix D: LCOM Form 75s (Surge)

```
40
 40   1 S  .99    1 1.0   0
 40   2 S  .98    1 1.0   0
 40   3 S  .97    1 1.0   0
 40   4 S  .96    1 1.0   0
 40   5 S  .95    1 1.0   0
 40   6 S  .94    1 1.0   0
 40   7 S  .93    1 1.0   0
 40   8 S  .92    1 1.0   0
 40   9 S  .91    1 1.0   0
 40  10 S  .90    1 1.0   0
 40  11 S  .89    1 1.0   0
 40  12 S  .88    1 1.0   0
 40  13 S  .87    1 1.0   0
 40  14 S  .86    1 1.0   0
 40  15 S  .85    1 1.0   0
 40  16 S  .84    1 1.0   0
 40  17 S  .83    1 1.0   0
 40  18 S  .82    1 1.0   0
 40  19 S  .81    1 1.0   0
 40  20 S  .80    1 1.0   0
 40  21 S  .79    1 1.0   0
 40  22 S  .78    1 1.0   0
 40  23 S  .77    1 1.0   0
 40  24 S  .76    1 1.0   0
 40  25 S  .75    1 1.0   0
 40  26 S  .74    1 1.0   0
 40  27 S  .73    1 1.0   0
 40  28 S  .72    1 1.0   0
 40  29 S  .71    1 1.0   0
 40  30 S  .70    1 1.0   0
 40  31 S  .69    1 1.0   0
 40  32 S  .68    1 1.0   0
 40  33 S  .67    1 1.0   0
 40  34 S  .66    1 1.0   0
 40  35 S  .65    1 1.0   0
 40  36 S  .64    1 1.0   0
 40  37 S  .63    1 1.0   0
 40  38 S  .62    1 1.0   0
 40  39 S  .61    1 1.0   0
 40  40 S  .60    1 1.0   0
 40  41 S  .59    1 1.0   0
 40  42 S  .58    1 1.0   0
 40  43 S  .57    1 1.0   0
 40  44 S  .56    1 1.0   0
 40  45 S  .55    1 1.0   0
 40  46 S  .54    1 1.0   0
 40  47 S  .53    1 1.0   0
 40  48 S  .52    1 1.0   0
 40  49 S  .51    1 1.0   0
 40  50 S  .50    1 1.0   0
 40  51 S  .49    1 1.0   0
 40  52 S  .48    1 1.0   0
 40  53 S  .47    1 1.0   0
 40  54 S  .46    1 1.0   0
 40  55 S  .45    1 1.0   0
 40  56 S  .44    1 1.0   0
 40  57 S  .43    1 1.0   0
 40  58 S  .42    1 1.0   0
 40  59 S  .41    1 1.0   0
 40  60 S  .40    1 1.0   0
```

```
40  61 S   .39      1 1.0     0
40  62 S   .38      1 1.0     0
40  63 S   .37      1 1.0     0
40  64 S   .36      1 1.0     0
40  65 S   .35      1 1.0     0
40  66 S   .34      1 1.0     0
40  67 S   .33      1 1.0     0
40  68 S   .32      1 1.0     0
40  69 S   .31      1 1.0     0
40  70 S   .30      1 1.0     0
40  71 S   .29      1 1.0     0
40  72 S   .28      1 1.0     0
40  73 S   .27      1 1.0     0
40  74 S   .26      1 1.0     0
40  75 S   .25      1 1.0     0
40  76 S   .24      1 1.0     0
40  77 S   .23      1 1.0     0
40  78 S   .22      1 1.0     0
40  79 S   .21      1 1.0     0
40  80 S   .20      1 1.0     0
40  81 S   .19      1 1.0     0
40  82 S   .18      1 1.0     0
40  83 S   .17      1 1.0     0
40  84 S   .16      1 1.0     0
40  85 S   .15      1 1.0     0
40  86 S   .14      1 1.0     0
40  87 S   .13      1 1.0     0
40  88 S   .12      1 1.0     0
40  89 S   .11      1 1.0     0
40  90 S   .10      1 1.0     0
40  91 S   .09      1 1.0     0
40  92 S   .08      1 1.0     0
40  93 S   .07      1 1.0     0
40  94 S   .06      1 1.0     0
40  95 S   .05      1 1.0     0
40  96 S   .04      1 1.0     0
40  97 S   .03      1 1.0     0
40  98 S   .02      1 1.0     0
40  99 S   .01      1 1.0     0
40 101 I H 0.0  0.0  1.0 23.99
40 102 I H 0.0  6.5   .38 9.5   .3812.0   .58 14.0 .58 16.0
40 102 I H 0.9118.0  1.00 6.49
40 103 I H 0.0  6.5   .47 9.5   .4712.0   .80 14.0 .80 16.0
40 103 I H 0.9318.0  1.00 6.49
40 299 I M 0.0 5.0   0.8 10.0   0.2 20.0
75
75F  1   *32 *101 C5       EXERC    1 1   0 13.2H 1.3H N 8.H 15M2  19999
75F  1    *1 *101 KC10     KEXER    1 1   0 18.4H 1.8H N 8.H 15M2  19999
75F  1   *21 *101 C5       CHNLA    1 1   0 26.7H 2.7H N 8.H 15M2  19999
75F  1   *33 *101 KC10     KCHAN    1 1   0 24.2H 2.4H N 8.H 15M2  19999
75F  1   *31 *101 C5       CHNLB    1 1   0 21.5H 2.1H N 8.H 15M2  19999
75F  1   *39 *101 C5       CHNLC    1 1   0 29.9H 2.9H N 8.H 15M2  19999
75F  1   *50 *101 C5       SAM22    1 1   0 17.0H 1.7H N 8.H 15M2  19999
75F  1   *15 *101 KC10     KSAAM    1 1   0 17.6H 1.7H N 8.H 15M2  19999
75F  1   *48 *101 C5       SAM21    1 1   0 16.8H 1.7H N 8.H 15M2  19999
75F  1    *7 *101 C5       JAATT    1 1   0 7.20H .72H N 8.H 15M2  19999
75F  1   *18 *101 KC10     KJAAT    1 1   0 6.30H .63H N 8.H 15M2  19999
75F  8     1 *102 C5       TRNGA    1 1   0 4.00H 1.0H N 8.H 15M2  79999
75F  8    10 *102 KC10     KTNGA    1 1   0 6.80H 1.0H N 8.H 15M2  79999
75F  8   *30 *102 KC10     KTNGA    1 1   0 6.80H 1.0H N 8.H 15M2  79999
75F  8   *24 *102 C5       TRNGA    1 1   0 4.00H 1.0H N 8.H 15M2  79999
75F  8     2 *102 C5       TRNGB    1 1   1 9.10H 1.1H N 8.H 15M2  79999
75F  8   *15 *102 C5       TRNGB    1 1   1 9.10H 1.1H N 8.H 15M2  79999
```

75F	9	1	*102	C5	TRNGA	1	1	0	4.00H	1.0H	N	8.H	15M2	79999
75F	9	*24	*102	C5	TRNGA	1	1	0	4.00H	1.0H	N	8.H	15M2	79999
75F	9	10	*102	KC10	KTNGA	1	1	0	6.80H	1.0H	N	8.H	15M2	79999
75F	9	*30	*102	KC10	KTNGA	1	1	0	6.80H	1.0H	N	8.H	15M2	79999
75F	9	2	*102	C5	TRNGB	1	1	1	9.10H	1.1H	N	8.H	15M2	79999
75F	9	*15	*102	C5	TRNGB	1	1	1	9.10H	1.1H	N	8.H	15M2	79999
75	9	1	0700	C5	FUR1B	1	1	0						289999
75	9	*42	0700	C5	HSC4	1	1	0						19999
75	9	1	0700	C5	IS04	1	1	0						119999
75	9	1	0700	KC10	A1CHK	1	1	0						119999
75	9	1	0700	KC10	A2CHK	1	1	0						119999
75	9	1	0700	KC10	CCHEK	1	1	0						119999
75	9	1	0700	KC10	RFURB	1	1	0						319999
75F	10	2	*102	C5	TRNGB	1	1	1	9.10H	1.1H	N	8.H	15M2	79999
75F	10	*15	*102	C5	TRNGB	1	1	1	9.10H	1.1H	N	8.H	15M2	79999
75F	10	1	*102	C5	TRNGA	1	1	0	4.00H	1.0H	N	8.H	15M2	79999
75F	10	*24	*102	C5	TRNGA	1	1	0	4.00H	1.0H	N	8.H	15M2	79999
75F	10	10	*102	KC10	KTNGA	1	1	0	6.80H	1.0H	N	8.H	15M2	79999
75F	10	*30	*102	KC10	KTNGA	1	1	0	6.80H	1.0H	N	8.H	15M2	79999
75F	11	2	*102	C5	TRNGB	1	1	1	9.10H	1.1H	N	8.H	15M2	79999
75F	11	*15	*102	C5	TRNGB	1	1	1	9.10H	1.1H	N	8.H	15M2	79999
75F	11	1	*102	C5	TRNGA	1	1	0	4.00H	1.0H	N	8.H	15M2	79999
75F	11	*24	*102	C5	TRNGA	1	1	0	4.00H	1.0H	N	8.H	15M2	79999
75F	11	10	*102	KC10	KTNGA	1	1	0	6.80H	1.0H	N	8.H	15M2	79999
75F	11	*30	*102	KC10	KTNGA	1	1	0	6.80H	1.0H	N	8.H	15M2	79999
75F	12	2	*102	C5	TRNGB	1	1	1	9.10H	1.1H	N	8.H	15M2	79999
75F	12	*15	*102	C5	TRNGB	1	1	1	9.10H	1.1H	N	8.H	15M2	79999
75F	12	1	*102	C5	TRNGA	1	1	0	4.00H	1.0H	N	8.H	15M2	79999
75F	12	*24	*102	C5	TRNGA	1	1	0	4.00H	1.0H	N	8.H	15M2	79999
75F	12	10	*102	KC10	KTNGA	1	1	0	6.80H	1.0H	N	8.H	15M2	79999
75F	12	*30	*102	KC10	KTNGA	1	1	0	6.80H	1.0H	N	8.H	15M2	79999
75F	13	1	*102	KC10	KTNGA	1	1	0	6.80H	1.0H	N	8.H	15M2	79999
75F	13	*46	*102	KC10	KTNGA	1	1	0	6.80H	1.0H	N	8.H	15M2	79999
75F	13	*83	*103	C5	TRNGB	1	1	1	9.10H	1.1H	N	8.H	15M2	79999
75F	13	*48	*103	C5	TRNGA	1	1	0	4.00H	1.0H	N	8.H	15M2	79999
75F	14	*83	*103	C5	TRNGB	1	1	1	9.10H	1.1H	N	8.H	15M2	79999
75F	14	*48	*103	C5	TRNGA	1	1	0	4.00H	1.0H	N	8.H	15M2	79999
75F	14	1	*102	KC10	KTNGA	1	1	0	6.80H	1.0H	N	8.H	15M2	79999
75F	14	*46	*102	KC10	KTNGA	1	1	0	6.80H	1.0H	N	8.H	15M2	79999

Appendix E: LCOM Change Card File

```
PERIOD,182,1825,WARMUP
LV1RPT,182,1825
LV2RPT,YES,YES
PSRRPT,YES,YES
RPT_STATS,KEY
SUPPRESS,ALL
AUTH,C5,32
AUTH,KC10,24
AUTH,N2-SE,12
AUTH,N2-SE-T,65000
FLY_WINDOW,ALL,0,2400
,FAILURE AND FIX CLOCKS FOR SGNSC
CKCNG,FN2,50.0H,0.0H
TKCNG,FIX-N2,2.0H,0.58H
TMULT,UNSC,1.00
CMULT,EXP,1.00
,FAILURE CLOCK IN SORTIES
CKCNG,F11LCH5,206.0D,0.0D
CKCNG,F11LCK5,206.0D,0.0D
CKCNG,F13AAA5,16.44D,0.0D
CKCNG,F13FCN5,411.0D,0.0D
CKCNG,F13LA05,0.83D,0.0D
CKCNG,F13LC05,6.42D,0.0D
CKCNG,F24ALP5,206.0D,0.0D
CKCNG,F91AAF5,206.0D,0.0D
CKCNG,F010005,20.0D,0.0D
CKCNG,F13AA01,12.13D,0.0D
CKCNG,F13AE01,19.4D,0.0D
CKCNG,F13BA01,12.13D,0.0D
CKCNG,F13DAB1,8.82D,0.0D
CKCNG,F13DBB1,16.17D,0.0D
CKCNG,F45ABH1,206.0D,0.0D
CKCNG,F46GJ01,7.46D,0.0D
CKCNG,F010001,20.0D,0.0D
STOP
```

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14. ABSTRACT

The purpose of this research was to illuminate crucial areas in analyzing AGE needs on an operational flightline and assist in determination of AGE inventory levels. Further refinements could result in more objective and accurate assessments of actual flightline AGE needs and associated risks involved with reduction of AGE inventory levels.

The research in this thesis consists of a discrete event simulation to determine desired AGE inventory level through an analysis of aircraft launches and wait time for AGE support by varying AGE (mean time between failure) MTBF and AGE inventory. Stochastic inputs for aircraft failures, AGE delivery times, and AGE MTBF were used. The scope of this effort was primarily concerned with an appropriate methodology to determine actual AGE requirements through analysis of consumption patterns and risk to reach a desired service level.

The result of this effort was a defined methodological approach in determination of AGE levels that could be applied across aircraft and AGE type.

15. SUBJECT TERMS

Modular Aircraft Support System (MASS), Aerospace Ground Equipment (AGE), Discrete Event Simulation, Self-Generating Nitrogen Servicing Cart (SGNSC), Resource Capacity, Service Capacity, Inventory

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