ARMY RESEARCH LABORATORY

Initial Assessment of the Manpower Requirements for the Army Airborne Command and Control System (A2C2S) System Operator Via the Improved Performance Research Integration Tool (IMPRINT)

By Thomas J. Havir and David B. Durbin

ARL-TR-3317 **October 2004**

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Army Research Laboratory
Aberdeen Proving Ground, MD 21005-5425

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Thomas J. Havir and David B. Durbin
Human Research and Engineering Directorate, ARL

REPORT DOCUMENTATION PAGE

Form Approved
OMB No. 0704-0188

1. REPORT DATE *(DD-MM-YYYY)*	2. REPORT TYPE	3. DATES COVERED (From - To)
October 2004		2001-2003

4. TITLE AND SUBTITLE

Initial Assessment of the Manpower Requirements for the Army Airborne Command and Control System (A2C2S) System Operator Via the Improved Performance Research Integration Tool (IMPRINT)

5a. CONTRACT NUMBER

5b. GRANT NUMBER

5c. PROGRAM ELEMENT NUMBER

6. AUTHOR(S)

Thomas J. Havir and David B. Durbin (both of ARL)

5d. PROJECT NUMBER
62716AH70

5e. TASK NUMBER

5f. WORK UNIT NUMBER

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)

U.S. Army Research Laboratory
Human Research and Engineering Directorate
Aberdeen Proving Ground, MD 21005-5425

8. PERFORMING ORGANIZATION REPORT NUMBER

ARL-TR-3317

9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)

10. SPONSOR/MONITOR'S ACRONYM(S)

11. SPONSOR/MONITOR'S REPORT NUMBER(S)

12. DISTRIBUTION/AVAILABILITY STATEMENT

Approved for public release; distribution unlimited.

13. SUPPLEMENTARY NOTES

14. ABSTRACT

The Army airborne command and control system (A2C2S) is an airborne C2 system that commanders will use to command and control units engaged in military operations ranging from humanitarian support and homeland security through high-intensity conflict. The A2C2S will allow the commander and staff to quickly traverse the battlefield while exercising command and control over forces in joint, interagency, and multinational environments.

The U.S. Army Training and Doctrine Command System Manager-Battle Command (TSM-BC) requested the U.S. Army Research Laboratory's Human Research and Engineering Directorate to perform an IMPRINT analysis to determine the manpower requirements for the A2C2S system operator.

The model was constructed with engineering estimates of the reliability data for the system, and the wartime scenario was based on the operational mission profile for the system. The model was executed ten times as a baseline and ten times with stressors including temperature, humidity, mission-oriented protective posture level, sleepless hours, and noise. The model results indicated that the system operator man-hour requirement was 2056.71 hours per A2C2S. This time consisted of maintenance man-hours required to perform unscheduled maintenance and mission time since the system operator is required to participate as a member of the A2C2S during missions. Based on the results of this model, one system operator is required for each A2C2S to adequately perform unscheduled maintenance and to participate as a member of the A2C2S during missions. Several opportunities for future research are available to complement the findings in this report. As system development continues and more accurate RAM (reliability, availability, maintainability) data become available, the model should be revised to reflect the most current data. Also, the amount of scheduled maintenance anticipated on the systems should be estimated. Adding the scheduled maintenance requirements to the existing data would provide a very accurate estimate of the total number of system operator man-hours that are required to operate and maintain the A2C2S.

15. SUBJECT TERMS

A2C2S; IMPRINT; manpower; system operator

16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGES	19a. NAME OF RESPONSIBLE PERSON
a. REPORT	b. ABSTRACT	c. THIS PAGE			Thomas J. Havir
Unclassified	Unclassified	Unclassified	UL	40	19b. TELEPHONE NUMBER (*Include area code*) 334-255-2206

Standard Form 298 (Rev. 8/98)
Prescribed by ANSI Std. Z39.18

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1. Introduction

1.1 Background and Purpose

The U.S. Army Training and Doctrine Command (TRADOC) System Manager–Battle Command (TSM-BC) requested the U.S. Army Research Laboratory's (ARL) Human Research and Engineering Directorate to perform an Improved Performance Research Integration Tool (IMPRINT) analysis to determine the manpower requirements for the Army airborne command and control system (A2C2S) system operator.

The A2C2S operational requirements document (TRADOC Program Integration Office, 2004) states the following regarding system operators:

- A system administrator will not be required to occupy one of the operator positions while conducting command and control (C2) missions.
- A slight maintenance and support man-hour increase for the affected maintenance and support series is anticipated.
- It is expected that at least one of the members of the assigned mission crew will receive additional training in the detailed operation of all system components; this individual is called the A2C2S system operator. Additionally, the system operator is the expert on the A2C2S systems to train new personnel as well as provide troubleshooting and configuration advice before and during missions.

In October 2002, the U.S. Army Signal Center, Fort Gordon, Georgia, published a memorandum regarding the A2C2S system operator and supplied it to TSM-BC (*1*). The Signal Center determined that the signal support systems specialist (31U) (*2*) was the most appropriate military occupational specialty (MOS) to perform the duties of the A2C2S system operator and recommended that this MOS operate and maintain the system at the unit level.

The purpose of this assessment was to determine the manpower requirements for the system operator (31U) related to

1. Unscheduled maintenance requirements for the system operator and
2. Requirements of the system operator during operational missions.

1.2 Description of System

The A2C2S (see figure 1) is a C2 system consisting of an A-kit and a B-kit and will be hosted by the UH-60L and UH-60M Blackhawk helicopters. The A-kit is permanently affixed to the airframe and consists of antennas, wiring, and aircraft interfaces (power, structural, etc.) that enable the B-kit to be installed in the airframe.

Figure 1. A2C2S.

The B-kit, or mission equipment package, consists of operator workstations, computer systems, and the communications devices necessary to support the digital C2 process.

The A2C2S will host the following Army battle command system software to support continuous situation awareness: maneuver control system, maneuver control system-light, all-source analysis system-remote work station, all-source analysis system-light, advanced field artillery tactical data system, air and missile defense work station, battle command sustainment and support system, command and control personal computer, and force XXI battle command brigade and below to include blue force tracking.

Commanders will use the A2C2S to command and control units engaged in military operations ranging from humanitarian support and homeland security through high intensity conflict. The A2C2S will allow the commander and staff to quickly traverse the battlefield while exercising command and control over forces in joint, interagency, and multinational environments.

1.3 IMPRINT

IMPRINT is a stochastic network modeling tool designed to help assess the interaction of Soldier and system performance throughout the system life cycle, from concept and design through field testing and system improvements (*3*). It was developed by ARL in the 1990s. IMPRINT can be used as a system design and acquisition tool to help set realistic system requirements, to identify Soldier-driven constraints on system design, and to evaluate the capability of available manpower and personnel to effectively operate and maintain a system in the presence of

environmental stressors such as air temperature, noise levels, mission-oriented protective posture (MOPP) levels, and sleepless hours.

2. Method

2.1 Data Collection

Reliability, availability, and maintainability (RAM) data were obtained for A2C2S components. The data included a list of all components and the following information for each component: MOS required to perform the task, number of personnel to perform each task, component mean time between failure (MTBF), and component mean time to repair (MTTR). These data were available only for corrective maintenance actions (i.e. remove and replace components). The data were entered into IMPRINT to form the foundation of the maintenance model. Appendix A includes a table of the RAM data used.

The tactics, techniques, and procedures manual (*4*) for the A2C2S states that the system operator is responsible for managing the radio control/intercom control management software. Because of this responsibility, it will be necessary for the system operator to be a member of the A2C2S crew during missions. In addition, it is anticipated that the system operator will be responsible for most of the corrective or unscheduled maintenance of the A2C2S components. Representatives of ARL and the program manager's (PM) office constructed a list of maintenance tasks for which the system operator would be the primary maintainer. The system operator was assigned all maintenance tasks associated with the A2C2S B-kit. Appendix A shows a detailed list of these tasks.

The A2C2S operational mode summary and mission profile was used to estimate the number of wartime operating hours for the A2C2S. A southwest Asia scenario was used over a 180-day period. To further define the mission to be flown by the A2C2S, representatives from ARL, TSM-BC, and the U.S. Army Aviation Center's Directorate of Combat Developments developed a mission scenario consisting of all segments of a typical mission and the duration of each segment (see table 1). These data were used to create a mission scenario in IMPRINT and to determine the approximate number of missions required to reach the anticipated operating hours over the duration of the simulation. Based on these data, the model was created to run approximately 117 missions for a total operating time of approximately 2,048 hours per A2C2S for the 180-day period.

The prioritized distribution plan for the A2C2S was used to further refine the mission scenario in IMPRINT (*5*). The number of systems assigned to each unit varies from one to six (see table 2). Since 46% of the units receiving the A2C2S are scheduled to receive four systems, the model was modified to simulate a division unit with four A2C2S aircraft.

Table 1. A2C2S mission segments.

Wartime A2C2S Scenario	Duration (hours)
Move from assembly area to tactical operations center (TOC)	1.0
Complete system initialization	0.5
Move from TOC to forward location	1.0
Perform airborne/ground operations	11.9
Return to TOC	1.0
Move from TOC to forward arming and refueling point	0.7
Refuel aircraft	0.4
Return to assembly area	1.0
Total operating and alert time	17.5

Table 2. Summary of the prioritized distribution plan.

Number of A2C2S Assigned	Percentage of Units
1 System	23%
3 Systems	17%
4 Systems	46%
5 Systems	3%
6 Systems	11%

2.2 Data Analysis

The simulation was executed 10 times with different random number "seeds[1]" during each trial to ensure pseudo-random results on each trial. In order to represent a worst case scenario, the model was run an additional 10 times with an option in IMPRINT known as "stressors". Stressors are variables in the environment that have the ability to adversely affect human performance and accuracy. To calculate the number of man-hours required to perform corrective maintenance tasks during adverse conditions, all the available stressors were used at their worst case values. The result is expected to be a representation of the maximum number of maintenance man-hours required to perform the system operator tasks in the worst conditions. Table 3 shows the stressors used and the value for each.

Table 3. Stressors included in worst case wartime model.

Stressors	Value
Temperature	112+ °F
Humidity	91% to 100%
MOPP level	4
Sleepless hours	96
Noise	110+ db

We calculated the total manpower requirements for the system operator by summing the following two components: unscheduled maintenance man-hours (MMH) and operating hours. Data were not available to estimate the number of scheduled maintenance hours required to

[1]These are numbers manually entered into simulators. They are used to manually change the starting point of the random number generator.

support the A2C2S. While scheduled maintenance should be considered when one is estimating the manpower required for the system operator, the sum of the unscheduled MMH and system operating hours composes a large percentage of the total manpower requirements for the A2C2S system operator.

2.3 Assumptions and Limitations

Several assumptions and limitations were inherent in this simulation and should be considered when one is interpreting the results. The A2C2S is in the early stages of the production and deployment phase of the acquisition process; therefore, the RAM data that were used were based on engineering estimates and not operational data. The engineering estimates were used to determine MTBF and MTTR. The MOS responsible for each task and the number of personnel required to perform each task were estimates provided by the PM. Since none of the estimates included standard deviation for MTTR, it was estimated as being 10% of the MTTR. The 10% standard deviation was chosen as the estimate for maintenance tasks, based on input from maintenance subject matter experts.

Another assumption made during the construction of the model was that all A2C2S systems would be used simultaneously at all times. TSM-BC expressed concern about having appropriate manpower to support system operator responsibilities in this situation, so the model was constructed to represent this scenario.

The aircraft availability was assumed to be 100% throughout the model. This helps represent a worst case scenario since aircraft availability less than 100% would reduce the number of required maintenance man-hours.

Finally, the B-kit transfer is a transfer of the B-kit from one aircraft to another. This task will be performed by the system operator when aircraft maintenance restricts the use of the A2C2S in its host aircraft. This could not be represented in this model because neither the frequency of occurrence nor an accurate transfer time is currently known.

3. Results and Discussion

The dependent variables that were of primary interest in this study were system availability and system operator maintenance man-hours. The system availability was calculated by the following formula:

$$\text{Availability} = \frac{\text{(Scenario Length in Hours)} - \text{(Total Corrective Maintenance Hours)}}{\text{(Scenario Length in Hours)}}$$

The mean system availability was 99.91% without stressors and 99.84% with stressors. A t-test was performed on these means and showed a statistical difference ($t=14.318$, $p < 0.05$). While a

statistical difference was present between these means, the practical significance is not a concern because the requirements of the Block I system are 90% availability. The high availability resulted in the total number of operating hours in all trials to be equal, indicating that system availability did not prevent the systems from performing missions when requested by the simulation.

A statistical difference between the mean system operator maintenance man-hours also exists ($t=-2.832$, $p < 0.05$). This difference indicates that the presence of stressors in the environment significantly affected the ability of the system operator to perform maintenance on the A2C2S. Tables 4 and 5 show a summary of results from both models. Figure 2 shows a graphic representation of 31U maintenance man-hours with and without stressors.

Table 4. Summary of IMPRINT results (without stressors).

Trial No.	**Operating Hours**	**System Availability (percent)**	**31U Maintenance Man-Hours**
1	8190	99.93	16.65
2	8190	99.88	28.52
3	8190	99.90	18.66
4	8190	99.92	12.12
5	8190	99.91	21.07
6	8190	99.92	19.71
7	8190	99.90	18.67
8	8190	99.92	17.09
9	8190	99.91	22.74
10	8190	99.91	23.66
Mean	8190	99.91	19.89

Table 5. Summary of IMPRINT results (with stressors).

Trial No.	**Operating Hours**	**System Availability (percent)**	**31U Maintenance Man-Hours**
1	8190	99.87	33.16
2	8190	99.78	53.82
3	8190	99.84	34.33
4	8190	99.87	21.49
5	8190	99.82	43.40
6	8190	99.86	34.97
7	8190	99.83	32.94
8	8190	99.86	30.43
9	8190	99.84	41.40
10	8190	99.84	42.42
Mean	8190	99.84	36.84

Because a significant difference between mean 31U maintenance man-hours existed, to derive the worst case results, the total number of 31U man-hours were calculated, based on the model using the stressors. Total maintenance man-hours for the 31U were 8226.84. We calculate this by summing the total mean operating hours and the 31U maintenance man-hours from the

model. Since the model was run with four A2C2S's, this number was divided by four to determine the 31U manpower required per A2C2S. This result was 2056.71 hours.

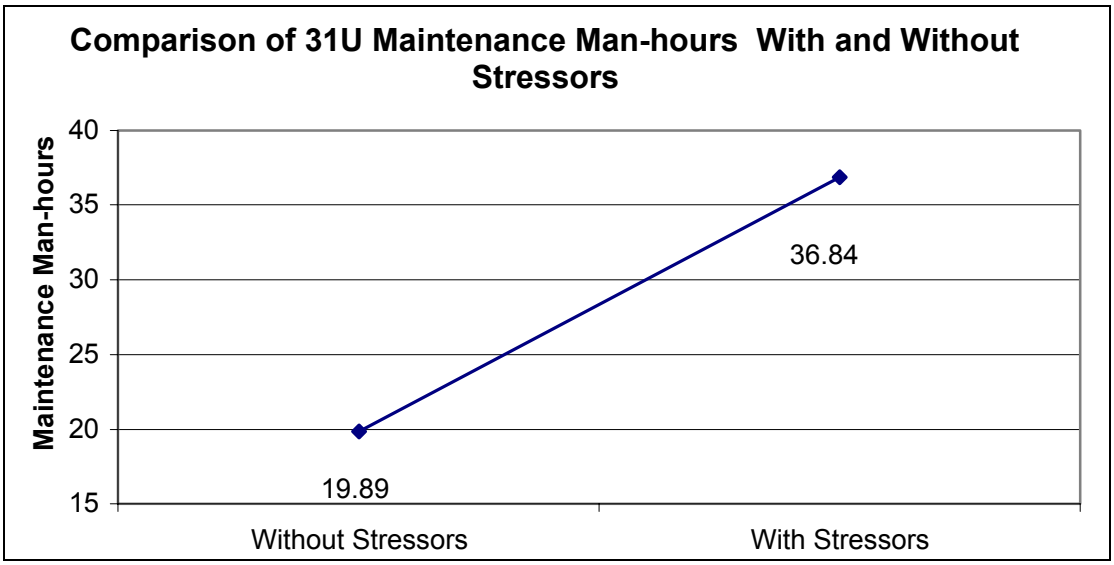

Figure 2. Comparison of 31U maintenance man-hours with and without stressors.

Based on data provided by the U.S. Army Human Resources Command, soldiers are anticipated to perform approximately 12-hour work days, 7 days a week during wartime missions. Based on this schedule, a 180-day cycle would be equivalent to 2,160 hours. Therefore, the number of system operators required per A2C2S B-kit is 0.95.

4. Recommendations

The finding of this initial assessment is that one system operator per A2C2S will be required to operate and perform unscheduled maintenance on the system. Preventive maintenance requirements of the system are currently unknown, and future studies should be performed to determine these requirements. If preventive maintenance requirements exceed 103.29 hours per A2C2S in a 180-day wartime scenario, then additional manpower would be required to adequately support the system.

Several opportunities for future research are available to complement the findings in this report. As system development continues and more accurate RAM data become available, the model should be revised to reflect the most current data. Also, the amount of preventive maintenance anticipated on the systems should be estimated. Adding the preventive maintenance requirements to the existing data would provide a very accurate estimate of the total number of system operator man-hours that are required to operate and maintain the A2C2S.

5. References

1. Zimmerman, C.L. *MOS Determination for the A2C2S*; memorandum; HQ, U.S. Army Signal Center and Fort Gordon: Fort Gordon, GA, 2002.
2. Department of the Army Headquarters. *Military Occupational Classification and Structure*. DA PAM 611-21: Retrieved July 2003 from http://www.usapa.army.mil/pdffiles/p611_21.pdf, 1999.
3. U.S. Army Research Laboratory. *IMPRINT: Improved Performance Research and Integration Tool*, 2002. Retrieved July 2003 from http://www.arl.army.mil/ARL-Directorates/HRED/imb/imprint/imprint.htm.
4. Department of the Army Headquarters. Draft Army Airborne Command and Control System Tactics Techniques and Procedures. Unpublished manuscript, 2002.
5. Gaffney, M. J. *Prioritized Distribution Plan for the Army Airborne Command and Control System (A2C2S)*; memorandum; Department of the Army, Office of the Deputy Chief of Staff, G-3: Washington, DC, 2002.

6. Bibliography

MicroAnalysis and Design. Improved Performance Research Integration Tool (IMPRINT) Analysis Guide Version 5.0. APG, MD: U.S. Army Research Laboratory, Human Research and Engineering Directorate, 1999.

MicroAnalysis and Design. Improved Performance Research Integration Tool (IMPRINT) Users Guide Version 6.0. APG, MD: U.S. Army Research Laboratory, Human Research and Engineering Directorate, 2002.

TRADOC Program Integration Office – Army Battle Command System. (2002). Army Airborne Command and Control System Operational Mode Summary and Mission Profile. U.S. Army Combined Arms Center, Fort Leavenworth, KS.

TRADOC Program Integration Office – Army Battle Command System. (2004). Operational Requirements Document for the Army Airborne Command and Control System. U.S. Army Combined Arms Center, Fort Leavenworth, KS.

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Appendix A. Reliability, Availability, and Maintainability Data

	EQUIPMENT	KIT	QTY	MOS	# MOS	TOTAL EFFECTIVE FAILURE RATE (FPMH)	MTBF (HOURS)	MTTR (HRS)
1)	SINCGARS VHF-FM #1: Antenna Installation	A-Kit	1	68N	1	10.18	98231.83	1.00
2)	SINCGARS VHF-FM #2: Antenna Installation	A-Kit	1	68N	1	10.18	98231.83	1.00
3)	SINCGARS VHF-FM #3: Antenna Installation	A-Kit	1	68N	1	10.18	98231.83	1.00
4)	SINCGARS VHF-FM #4: Antenna Installation	A-Kit	1	68N	1	10.18	98231.83	1.00
5)	HAVEQUICK #1: Antenna Installation	A-Kit	1	68N	1	10.18	98231.83	1.00
6)	HAVEQUICK #2: Antenna Installation	A-Kit	1	68N	1	10.18	98231.83	1.00
7)	EPLRS Antenna Installation	A-Kit	1	68N	1	0.51	1960784.31	1.00
8)	NTDR Antenna Installation	A-Kit	1	68N	1	0.51	1960784.31	1.00
9)	GPS/SATCOM: Antenna Installation	A-Kit	1	68N	1	63.43	15765.41	1.00
10)	ICS Override & 220 Controller	A-Kit	1	68N	1	5.00	200000.00	1.00
11)	A to B-Kit Interface	A-Kit	1	68N	1	0.13	7692307.69	2.00
12)	External Inteface	A-Kit	1	68N	1	0.51	1960784.31	2.00
13)	Cooling Interface Panel	A-Kit	1	68N	1	0.51	1960784.31	2.00
14)	Electrical Installation (Cables)	A-Kit	1	68F	1	2.14	467289.72	0.20
15)	Operator Workstation #1	B-Kit	1	31U	1	278.17	3594.92	0.38
16)	Operator Workstation #2	B-Kit	1	31U	1	278.14	3595.31	0.38
17)	Operator Workstation #4	B-Kit	1	31U	1	278.14	3595.31	0.38
18)	Operator Workstation #5	B-Kit	1	31U	1	278.14	3595.31	0.38
19)	Operator Workstation # 3: Mission Commander	B-Kit	1	31U	1	278.12	3595.57	0.38
20)	LapTop	B-Kit	1	31U	1	280.00	3571.43	0.20
21)	NTDR Communications Rack	B-Kit	1	31U	1	276.12	3621.65	2.00
22)	EPLRS	B-Kit	1	31U	1	198.55	5036.51	0.24
23)	PLGR	B-Kit	1	31U	1	48.48	20625.00	0.20
24)	SINGCARS	B-Kit	4	31U	1	860.02	1162.76	0.32
25)	ICS Controller (MCSU)	B-Kit	1	31U	2	64.65	15468.75	0.50
26)	VHF/UHF Cosite Mitigation System Assembly	B-Kit	1	31U	2	225.48	4434.97	0.62
27)	HAVEQUICK-II AN/ARC-231	B-Kit	1	31U	1	240.69	4154.76	0.25
28)	SATCOM AN/ARC-231	B-Kit	1	31U	1	240.69	4154.76	0.25
29)	High Power Amplifier	B-Kit	1	31U	1	29.93	33410.07	0.25
30)	HAVEQUICK-I AN/ARC-231	B-Kit	1	31U	1	240.69	4154.76	0.25
31)	20 INCH COMMON DISPLAY - Thin client w/CPU	B-Kit	2	31U	2	254.55	3928.57	0.33
32)	Data Fill & Control Panel	B-Kit	1	31U	2	28.00	35714.29	0.50
33)	GPS Splitter	B-Kit	1	31U	1	12.73	78571.43	0.50
34)	Power Distribution Unit	B-Kit	1	31U	2	30.55	32738.10	0.48
35)	Other Misc Comm Rack Equipment	B-Kit	1	31U	1	10.23	97725.66	0.36
36)	Media Converter	B-Kit	1	31U	1	17.26	57937.43	2.00
37)	CISCO Ethernet Switch 2950	B-Kit	1	31U	1	45.62	21920.21	0.50
38)	Digital KVM Unit	B-Kit	1	31U	1	50.91	19642.51	0.50
39)	CISCO 3640 ROUTER	B-Kit	1	31U	1	98.12	10191.60	0.50
40)	MPU-1	B-Kit	1	31U	2	305.36	3274.82	0.26
41)	MPU-2	B-Kit	1	31U	2	305.36	3274.82	0.26
42)	Advanced Data Controller	B-Kit	1	31U	1	14.55	68750.00	0.10
43)	TCIM (Tact Int Comm Modem)	B-Kit	1	31U	1	38.44	26017.03	0.50
44)	Other Miscellaneous MCE Rack Equipment	B-Kit	1	31U	1	2.70	370619.95	0.20
45)	Ground Antenna System	B-Kit	1	31U	2	13.90	71951.86	0.08

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Appendix B. Maintenance Model Results – Baseline Wartime Scenario

Maintenance Summary

No Stressors

System: A2C2S Maintenance

Scenario Wartime Consolidated Trial: 1 Random Number Seed: 2	
Total Operating Hours	8190.00
Average Preventive Maintenance Hours	0.00
Average Corrective Maintenance Hours	4.25
Average Maintenance Per Operating Hour	0.00

Reliability and Availability

No Stressors

System: A2C2S Maintenance

Scenario: Wartime Consolidated Trial: 1 Random Number Seed: 2

Reliability Summary

Segments Requested	117.00
Segments Accomplished	117.00
Number of times Systems Requested	468
Number of times System Requests Accomplished	468

Availability Summary

Average Inherent Availability	99.93%
Average Achieved Availability	99.93%
Readiness	100.00%

Man-hour Requirements

No Stressors

System: A2C2S Maintenance

Scenario: Wartime Consolidated Trial: 1 Random Number Seed: 2

Org Level	MOS	Direct Maintenance
		Man-hours
Org	15T10	0.35
Org	31U10	16.65

Maintenance Summary

No Stressors

System: A2C2S Maintenance

Scenario Wartime Consolidated Trial: 2 Random Number Seed: 1471	
Total Operating Hours	8190.00
Average Preventive Maintenance Hours	0.00
Average Corrective Maintenance Hours	7.80
Average Maintenance Per Operating Hour	0.00

Reliability and Availability

No Stressors

System: A2C2S Maintenance

Scenario: Wartime Consolidated Trial: 2 Random Number Seed: 911

Reliability Summary

Segments Requested	117.00
Segments Accomplished	117.00
Number of times Systems Requested	468
Number of times System Requests Accomplished	468

Availability Summary

Average Inherent Availability	99.88%
Average Achieved Availability	99.88%
Readiness	100.00%

Man-hour Requirements

No Stressors

System: A2C2S Maintenance

Scenario: Wartime Consolidated Trial: 2 Random Number Seed: 1471

Org Level	**MOS**	**Direct Maintenance**
		Man-hours
Org	15T10	0.60
Org	31U10	28.52
Org	15N10	2.07

Maintenance Summary

No Stressors

System: A2C2S Maintenance

Scenario Wartime Consolidated Trial: 3 Random Number Seed: 2940	
Total Operating Hours	8190.00
Average Preventive Maintenance Hours	0.00
Average Corrective Maintenance Hours	6.18
Average Maintenance Per Operating Hour	0.00

Reliability and Availability

No Stressors

System: A2C2S Maintenance

Scenario: Wartime Consolidated Trial: 3 Random Number Seed: 2940

Reliability Summary

Segments Requested	117.00
Segments Accomplished	117.00
Number of times Systems Requested	468
Number of times System Requests Accomplished	468

Availability Summary

Average Inherent Availability	99.90%
Average Achieved Availability	99.90%
Readiness	100.00%

Man-hour Requirements

No Stressors

System: A2C2S Maintenance

Scenario: Wartime Consolidated Trial: 3 Random Number Seed: 2940

Org Level	MOS	Direct Maintenance
		Man-hours
Org	15T10	0.70
Org	31U10	18.66
Org	15N10	5.35

Maintenance Summary

No Stressors

System: A2C2S Maintenance

Scenario Wartime Consolidated Trial: 4 Random Number Seed: 4409	
Total Operating Hours	8190.00
Average Preventive Maintenance Hours	0.00
Average Corrective Maintenance Hours	4.86
Average Maintenance Per Operating Hour	0.00

Reliability and Availability

No Stressors

System: A2C2S Maintenance

Scenario: Wartime Consolidated Trial: 4 Random Number Seed: 4409

Reliability Summary

Segments Requested	117.00
Segments Accomplished	117.00
Number of times Systems Requested	468
Number of times System Requests Accomplished	468

Availability Summary

Average Inherent Availability	99.92%
Average Achieved Availability	99.92%
Readiness	100.00%

Man-hour Requirements

No Stressors

System: A2C2S Maintenance

Scenario: Wartime Consolidated Trial: 4 Random Number Seed: 4409

Org Level	MOS	Direct Maintenance
		Man-hours
Org	31U10	12.12
Org	15N10	7.30

Maintenance Summary

No Stressors

System: A2C2S Maintenance

Scenario Wartime Consolidated Trial: 5 Random Number Seed: 5878	
Total Operating Hours	8190.00
Average Preventive Maintenance Hours	0.00
Average Corrective Maintenance Hours	5.27
Average Maintenance Per Operating Hour	0.00

Reliability and Availability

No Stressors

System: A2C2S Maintenance

Scenario: Wartime Consolidated Trial: 5 Random Number Seed: 5878

Reliability Summary

Segments Requested	117.00
Segments Accomplished	117.00
Number of times Systems Requested	468
Number of times System Requests Accomplished	468

Availability Summary

Average Inherent Availability	99.91%
Average Achieved Availability	99.91%
Readiness	100.00%

Man-hour Requirements

No Stressors

System: A2C2S Maintenance

Scenario: Wartime Consolidated Trial: 5 Random Number Seed: 5878

Org Level	MOS	Direct Maintenance
		Man-hours
Org	31U10	21.07

Maintenance Summary

No Stressors

System: A2C2S Maintenance

Scenario Wartime Consolidated Trial: 6 Random Number Seed: 7347	
Total Operating Hours	8190.00
Average Preventive Maintenance Hours	0.00
Average Corrective Maintenance Hours	5.01
Average Maintenance Per Operating Hour	0.00

Reliability and Availability

No Stressors

System: A2C2S Maintenance

Scenario: Wartime Consolidated Trial: 6 Random Number Seed: 7347

Reliability Summary

Segments Requested	117.00
Segments Accomplished	117.00
Number of times Systems Requested	468
Number of times System Requests Accomplished	468

Availability Summary

Average Inherent Availability	99.92%
Average Achieved Availability	99.92%
Readiness	100.00%

Man-hour Requirements

No Stressors

System: A2C2S Maintenance

Scenario: Wartime Consolidated Trial: 6 Random Number Seed: 7347

Org Level	MOS	Direct Maintenance
		Man-hours
Org	15T10	0.34
Org	31U10	19.71

Maintenance Summary

No Stressors

System: A2C2S Maintenance

Scenario Wartime Consolidated Trial: 7 Random Number Seed: 8816	
Total Operating Hours	8190.00
Average Preventive Maintenance Hours	0.00
Average Corrective Maintenance Hours	5.69
Average Maintenance Per Operating Hour	0.00

Reliability and Availability

No Stressors

System: A2C2S Maintenance

Scenario: Wartime Consolidated Trial: 7 Random Number Seed: 8816

Reliability Summary

Segments Requested	117.00
Segments Accomplished	117.00
Number of times Systems Requested	468
Number of times System Requests Accomplished	468

Availability Summary

Average Inherent Availability	99.90%
Average Achieved Availability	99.90%
Readiness	100.00%

Man-hour Requirements

No Stressors

System: A2C2S Maintenance

Scenario: Wartime Consolidated Trial: 7 Random Number Seed: 8816

Org Level	MOS	Direct Maintenance
		Man-hours
Org	15T10	0.37
Org	31U10	18.67
Org	15N10	3.70

Maintenance Summary

No Stressors

System: A2C2S Maintenance

Scenario Wartime Consolidated Trial: 8 Random Number Seed: 10285	
Total Operating Hours	8190.00
Average Preventive Maintenance Hours	0.00
Average Corrective Maintenance Hours	4.56
Average Maintenance Per Operating Hour	0.00

Reliability and Availability

No Stressors

System: A2C2S Maintenance

Scenario: Wartime Consolidated Trial: 8 Random Number Seed: 10285

Reliability Summary

Segments Requested	117.00
Segments Accomplished	117.00
Number of times Systems Requested	468
Number of times System Requests Accomplished	468

Availability Summary

Average Inherent Availability	99.92%
Average Achieved Availability	99.92%
Readiness	100.00%

Man-hour Requirements

No Stressors

System: A2C2S Maintenance

Scenario: Wartime Consolidated Trial: 8 Random Number Seed: 10285

Org Level	MOS	Direct Maintenance
		Man-hours
Org	15T10	0.28
Org	31U10	17.09
Org	15N10	0.85

Maintenance Summary

No Stressors

System: A2C2S Maintenance

Scenario Wartime Consolidated Trial: 9 Random Number Seed: 11754	
Total Operating Hours	8190.00
Average Preventive Maintenance Hours	0.00
Average Corrective Maintenance Hours	6.32
Average Maintenance Per Operating Hour	0.00

Reliability and Availability

No Stressors

System: A2C2S Maintenance

Scenario: Wartime Consolidated Trial: 9 Random Number Seed: 11754

Reliability Summary

Segments Requested	117.00
Segments Accomplished	117.00
Number of times Systems Requested	468
Number of times System Requests Accomplished	468

Availability Summary

Average Inherent Availability	99.91%
Average Achieved Availability	99.91%
Readiness	100.00%

Man-hour Requirements

No Stressors

System: A2C2S Maintenance

Scenario: Wartime Consolidated Trial: 9 Random Number Seed: 11754

Org Level	MOS	Direct Maintenance
		Man-hours
Org	15T10	0.62
Org	31U10	22.74
Org	15N10	1.91

Maintenance Summary

No Stressors

System: A2C2S Maintenance

Scenario Wartime Consolidated Trial: 10 Random Number Seed: 13223	
Total Operating Hours	8190.00
Average Preventive Maintenance Hours	0.00
Average Corrective Maintenance Hours	6.00
Average Maintenance Per Operating Hour	0.00

Reliability and Availability

No Stressors

System: A2C2S Maintenance

Scenario: Wartime Consolidated Trial: 10 Random Number Seed: 13223

Reliability Summary

Segments Requested	117.00
Segments Accomplished	117.00
Number of times Systems Requested	468
Number of times System Requests Accomplished	468

Availability Summary

Average Inherent Availability	99.91%
Average Achieved Availability	99.91%
Readiness	100.00%

Man-hour Requirements

No Stressors

System: A2C2S Maintenance

Scenario: Wartime Consolidated Trial: 10 Random Number Seed: 13223

Org Level	MOS	Direct Maintenance
		Man-hours
Org	15T10	0.34
Org	31U10	23.66

Appendix C. Maintenance Model Results –Wartime Scenario With Stressors

Maintenance Summary

Stressors Added

System: A2C2S Maintenance

Scenario Wartime Consolidated Trial: 1 Random Number Seed: 2	
Total Operating Hours	8190.00
Average Preventive Maintenance Hours	0.00
Average Corrective Maintenance Hours	8.43
Average Maintenance Per Operating Hour	0.00

Reliability and Availability

Stressors Added

System: A2C2S Maintenance

Scenario: Wartime Consolidated Trial: 1 Random Number Seed: 2

Reliability Summary

Segments Requested	117.00
Segments Accomplished	117.00
Number of times Systems Requested	468
Number of times System Requests Accomplished	468

Availability Summary

Average Inherent Availability	99.87%
Average Achieved Availability	99.87%
Readiness	100.00%

Man-hour Requirements

Stressors Added

System: A2C2S Maintenance

Scenario: Wartime Consolidated Trial: 1 Random Number Seed: 2

Org Level	MOS	Direct Maintenance
		Man-hours
Org	15T10	0.57
Org	31U10	33.16

Maintenance Summary

Stressors Added

System: A2C2S Maintenance

Scenario Wartime Consolidated Trial: 2 Random Number Seed: 1471	
Total Operating Hours	8190.00
Average Preventive Maintenance Hours	0.00
Average Corrective Maintenance Hours	14.24
Average Maintenance Per Operating Hour	0.00

Reliability and Availability

Stressors Added

System: A2C2S Maintenance

Scenario: Wartime Consolidated Trial: 2 Random Number Seed: 1471

Reliability Summary

Segments Requested	117.00
Segments Accomplished	117.00
Number of times Systems Requested	468
Number of times System Requests Accomplished	468

Availability Summary

Average Inherent Availability	99.78%
Average Achieved Availability	99.78%
Readiness	100.00%

Man-hour Requirements

Stressors Added

System: A2C2S Maintenance

Scenario: Wartime Consolidated Trial: 2 Random Number Seed: 1471

Org Level	MOS	Direct Maintenance
		Man-hours
Org	15T10	1.05
Org	31U10	53.82
Org	15N10	2.07

Maintenance Summary

Stressors Added

System: A2C2S Maintenance

Scenario Wartime Consolidated Trial: 3 Random Number Seed: 2940	
Total Operating Hours	8190.00
Average Preventive Maintenance Hours	0.00
Average Corrective Maintenance Hours	10.21
Average Maintenance Per Operating Hour	0.00

Reliability and Availability

Stressors Added

System: A2C2S Maintenance

Scenario: Wartime Consolidated Trial: 3 Random Number Seed: 2940

Reliability Summary

Segments Requested	117.00
Segments Accomplished	117.00
Number of times Systems Requested	468
Number of times System Requests Accomplished	468

Availability Summary

Average Inherent Availability	99.84%
Average Achieved Availability	99.84%
Readiness	100.00%

Man-hour Requirements

Stressors Added

System: A2C2S Maintenance

Scenario: Wartime Consolidated Trial: 3 Random Number Seed: 2940

Org Level	MOS	Direct Maintenance
		Man-hours
Org	15T10	1.15
Org	31U10	34.33
Org	15N10	5.35

Maintenance Summary

Stressors Added

System: A2C2S Maintenance

Scenario Wartime Consolidated Trial: 4 Random Number Seed: 4409	
Total Operating Hours	8190.00
Average Preventive Maintenance Hours	0.00
Average Corrective Maintenance Hours	7.18
Average Maintenance Per Operating Hour	0.00

Reliability and Availability

Stressors Added

System: A2C2S Maintenance

Scenario: Wartime Consolidated Trial: 4 Random Number Seed: 4409

Reliability Summary

Segments Requested	117.00
Segments Accomplished	117.00
Number of times Systems Requested	468
Number of times System Requests Accomplished	468

Availability Summary

Average Inherent Availability	99.87%
Average Achieved Availability	99.87%
Readiness	100.00%

Man-hour Requirements

Stressors Added

System: A2C2S Maintenance

Scenario: Wartime Consolidated Trial: 4 Random Number Seed: 4409

Org Level	MOS	Direct Maintenance
		Man-hours
Org	31U10	21.49
Org	15N10	7.21

Maintenance Summary

Stressors Added

System: A2C2S Maintenance

Scenario Wartime Consolidated Trial: 5 Random Number Seed: 5878	
Total Operating Hours	8190.00
Average Preventive Maintenance Hours	0.00
Average Corrective Maintenance Hours	10.85
Average Maintenance Per Operating Hour	0.01

Reliability and Availability

Stressors Added

System: A2C2S Maintenance

Scenario: Wartime Consolidated Trial: 5 Random Number Seed: 5878

Reliability Summary

Segments Requested	117.00
Segments Accomplished	117.00
Number of times Systems Requested	468
Number of times System Requests Accomplished	468

Availability Summary

Average Inherent Availability	99.82%
Average Achieved Availability	99.82%
Readiness	100.00%

Man-hour Requirements

Stressors Added

System: A2C2S Maintenance

Scenario: Wartime Consolidated Trial: 5 Random Number Seed: 5878

Org Level	**MOS**	**Direct Maintenance**
		Man-hours
Org	31U10	43.40

Maintenance Summary

Stressors Added

System: A2C2S Maintenance

Scenario Wartime Consolidated Trial: 6 Random Number Seed: 7347	
Total Operating Hours	8190.00
Average Preventive Maintenance Hours	0.00
Average Corrective Maintenance Hours	8.88
Average Maintenance Per Operating Hour	0.00

Reliability and Availability

Stressors Added

System: A2C2S Maintenance

Scenario: Wartime Consolidated Trial: 6 Random Number Seed: 7347

Reliability Summary

Segments Requested	117.00
Segments Accomplished	117.00
Number of times Systems Requested	468
Number of times System Requests Accomplished	468

Availability Summary

Average Inherent Availability	99.86%
Average Achieved Availability	99.86%
Readiness	100.00%

Man-hour Requirements

Stressors Added

System: A2C2S Maintenance

Scenario: Wartime Consolidated Trial: 6 Random Number Seed: 7347

Org Level	MOS	Direct Maintenance
		Man-hours
Org	15T10	0.56
Org	31U10	34.97

Maintenance Summary

Stressors Added

System: A2C2S Maintenance

Scenario Wartime Consolidated Trial: 7 Random Number Seed: 8816	
Total Operating Hours	8190.00
Average Preventive Maintenance Hours	0.00
Average Corrective Maintenance Hours	9.31
Average Maintenance Per Operating Hour	0.00

Reliability and Availability

Stressors Added

System: A2C2S Maintenance

Scenario: Wartime Consolidated Trial: 7 Random Number Seed: 8816

Reliability Summary

Segments Requested	117.00
Segments Accomplished	117.00
Number of times Systems Requested	468
Number of times System Requests Accomplished	468

Availability Summary

Average Inherent Availability	99.83%
Average Achieved Availability	99.83%
Readiness	100.00%

Man-hour Requirements

Stressors Added

System: A2C2S Maintenance

Scenario: Wartime Consolidated Trial: 7 Random Number Seed: 8816

Org Level	MOS	Direct Maintenance
		Man-hours
Org	15T10	0.60
Org	31U10	32.94
Org	15N10	3.70

Maintenance Summary

Stressors Added

System: A2C2S Maintenance

Scenario Wartime Consolidated Trial: 8 Random Number Seed: 10285	
Total Operating Hours	8190.00
Average Preventive Maintenance Hours	0.00
Average Corrective Maintenance Hours	7.95
Average Maintenance Per Operating Hour	0.00

Reliability and Availability

Stressors Added

System: A2C2S Maintenance

Scenario: Wartime Consolidated Trial: 8 Random Number Seed: 10285

Reliability Summary

Segments Requested	117.00
Segments Accomplished	117.00
Number of times Systems Requested	468
Number of times System Requests Accomplished	468

Availability Summary

Average Inherent Availability	99.86%
Average Achieved Availability	99.86%
Readiness	100.00%

Man-hour Requirements

Stressors Added

System: A2C2S Maintenance

Scenario: Wartime Consolidated Trial: 8 Random Number Seed: 10285

Org Level	MOS	Direct Maintenance
		Man-hours
Org	15T10	0.50
Org	31U10	30.43
Org	15N10	0.85

Maintenance Summary

Stressors Added

System: A2C2S Maintenance

Scenario Wartime Consolidated Trial: 9 Random Number Seed: 11754	
Total Operating Hours	8190.00
Average Preventive Maintenance Hours	0.00
Average Corrective Maintenance Hours	11.09
Average Maintenance Per Operating Hour	0.01

Reliability and Availability

Stressors Added

System: A2C2S Maintenance

Scenario: Wartime Consolidated Trial: 9 Random Number Seed: 11754

Reliability Summary

Segments Requested	117.00
Segments Accomplished	117.00
Number of times Systems Requested	468
Number of times System Requests Accomplished	468

Availability Summary

Average Inherent Availability	99.84%
Average Achieved Availability	99.84%
Readiness	100.00%

Man-hour Requirements

Stressors Added

System: A2C2S Maintenance

Scenario: Wartime Consolidated Trial: 9 Random Number Seed: 11754

Org Level	MOS	Direct Maintenance
		Man-hours
Org	15T10	1.06
Org	31U10	41.40
Org	15N10	1.91

Maintenance Summary

Stressors Added

System: A2C2S Maintenance

Scenario Wartime Consolidated Trial: 10 Random Number Seed: 13223	
Total Operating Hours	8190.00
Average Preventive Maintenance Hours	0.00
Average Corrective Maintenance Hours	10.74
Average Maintenance Per Operating Hour	0.01

Reliability and Availability

Stressors Added

System: A2C2S Maintenance

Scenario: Wartime Consolidated Trial: 10 Random Number Seed: 13223

Reliability Summary

Segments Requested	117.00
Segments Accomplished	117.00
Number of times Systems Requested	468
Number of times System Requests Accomplished	468

Availability Summary

Average Inherent Availability	99.84%
Average Achieved Availability	99.84%
Readiness	100.00%

Man-hour Requirements

Stressors Added

System: A2C2S Maintenance

Scenario: Wartime Consolidated Trial: 10 Random Number Seed: 13223

Org Level	MOS	Direct Maintenance
		Man-hours
Org	15T10	0.56
Org	31U10	42.42

Glossary of Acronyms

A2C2S	Army airborne command and control system
ARL	Army Research Laboratory
C2	command and control
CSSCS	Combat Service Support Control System
IMPRINT	Improved Performance Research Integration Tool
MMH	maintenance man-hours
MOPP	mission-oriented protective posture
MOS	military occupational specialty
MTBF	mean time between failure
MTTR	mean time to repair
PM	Program Manager
RAM	reliability, availability, maintainability
TRADOC	Training and Doctrine Command
TSM-BC	TRADOC System Manager–Battle Command

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