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An Investigation into Execution Delays During Naval Vessels' Availabilities

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The U.S. Naval Shipyards' schedules revolve around the planning and execution of Naval vessel "availabilities," essential maintenance periods during the life of a vessel with the purpose of maintaining and improving the operational readiness and its fighting ability. Because of the high operational tempo for Naval vessels today, the four public Naval shipyards are continually challenged to complete depot-level availabilities on schedule. In order to support the completion of availabilities in a timely manner, this article presents a summary of execution delays (known as work stoppages), and an analysis on the impact of work stoppages during the execution phase. The work stoppage data are summarized to display possible trends based on the mean length and quantity of work stoppages across multiple availabilities, and possible predictors of availability lateness using a timed based metric are further investigated. The analysis of the data suggests that although no simple association exist between the quantity or length of work stoppage and the lateness of an availability, availabilities that finish on schedule tend to have had fewer work stoppages before the start of the availability as compared to the later finishing availabilities, signifying the importance of a complete and thoroughly supported availability plan. This study assists the Naval shipyard leadership in understanding a contributing factor to availability lateness, and can be applied to the shipyard maintenance community in which delays are experienced throughout a project.

KEY WORDS:CNO; Availability Lateness; Work Stoppages

NOMENCLATURE

CM	Continuous Maintenance
CNO	Chief of Naval Operational
DSRA	Docking Selected Restricted Availability
IC	Interference/Coordination
MAT	Material
MMP	Major Maintenance Period
NNSY	Norfolk Naval Shipyard
PHNSY	Pearl Harbor Naval Shipyard and IMF
PIA	Planned Incremental Availability
PNSY	Portsmouth Naval Shipyard
PSNSY	Puget Sound Naval Shipyard and IMF
RSC	Resources
SAF	Safety
SRA	Selected Restricted Availability
TD	Technical Direction
TL	Tooling
W	Workmanship/Rework
WC	Work Control

INTRODUCTION

Naval vessel maintenance and modernization is a necessary, reoccurring process to prevent decline in a vessel's operational readiness. These maintenance periods, known as "availabilities," are scheduled throughout a vessel's operational life and conducted pier side or in dry-dock. Specifically, availabilities scheduled at the highest operational level and conducted in the naval shipyards, are called Chief of Naval Operations (CNO) availabilities. Schedule management of an availability is critical in ensuring the required maintenance and modernization work is completed on time; that is, before or on the scheduled completion date, to prevent impact to fleet readiness. However, late completion of availabilities is not uncommon, and due to this reality, a study is conducted to identify if execution delays, known as work stoppages, can contribute to availability lateness.

The four public naval shipyards: Puget Sound Naval Shipyard and Intermediate Maintenance Facility (PSNSY), Pearl Harbor Naval Shipyard and Intermediate Maintenance Facility (PHNSY), Norfolk Naval Shipyard (NNSY), and Portsmouth Naval Shipyard (PNSY), are continually challenged to complete submarine availabilities on schedule ("Potential Thesis Topic," NAVSEA 07, 2011). Historical data over the past six years show only 10%–45% of the all availabilities conducted finish on time. A naval vessel's late delivery date back to operational status decreases the fleet commanders' operational readiness due to the reduced number of operational days available for vessels held beyond the original agreed upon completion date.

Historical work stoppage data are analyzed and focuses on the dynamic relationship between the scheduled availability duration and the number of work stoppages. In order to understand this relationship, the work stoppage data are organized by the reasons for delay and descriptive statistics are calculated and interpreted. The work stoppage data is also summarized by the number of delays occurring per unit time during an availability. This unit of measurement results in a clearer picture on the schedule/work stoppage interaction, but also allows for the early identification of an availability schedule overrun. The ultimate goal of the work stoppage research is to present work stoppage data in a new perspective to assist and better inform the Naval shipyards' decision makers on the impact of work stoppages.

CNO AVAILABILITY

An availability is defined as the time during which a U.S. Naval warship is made available to a maintenance activity for the accomplishment of maintenance and alterations. During an availability, the ship is rendered incapable of fully performing its assigned missions and tasks due to the nature of the repair work. The four naval shipyards analyzed in this study are considered the Naval Supervisory Authority (NSA), who is in charge of coordinating all the maintenance functions on hull, mechanical, electrical, and combat equipment and systems that are beyond the organizational capability or capacity of a ship (OPNAV N431 2010).

Navy Maintenance Program

The ships of the United States Navy are built with the latest technologies in the fields of structures, hydrodynamics, electrical, mechanical, and combat systems with the common goal of protecting the freedoms and executing the policies of the United States. As the responsibility to the United States Government and the people of the United States, and as described in the *Maintenance Policy for United States Navy Ships*, OPNAVINST 4700.7L, the Navy must achieve the desired operational availability levels at the lowest possible total ownership cost. The Navy's program for maintaining the readiness of its ships is separated into two distinct, yet closely related components, ship maintenance and ship modernization. The ship maintenance program is established to maintain the operational readiness of the ship and its currently installed systems; whereas the ship modernization program is established to increase ship capability and/or improve the reliability and maintainability of the existing systems.

Navy maintenance is classified into three capability levels, with each level increasing in capability required to perform the intended maintenance. The lowest maintenance level, organizational-level maintenance, consists of all maintenance actions within the capability of the ship's crew, known as ship's force. Typical organizational-level maintenance includes preventative maintenance (cleaning, lubricating, and operability testing) and corrective maintenance (component replacement and troubleshooting). This level of maintenance is promulgated by the ship specific maintenance plan. The second level, intermediate-level maintenance, is defined as the maintenance that requires skills and facilities normally beyond those of the organizational level but does not require depot-level skills. Intermediate-level maintenance is performed by fleet maintenance activities (i.e., shore-based maintenance commands, naval shipyards, and regional maintenance centers) and is promulgated by the fleet commander or authorized representative. Maintenance actions scheduled and accomplished at the intermediate-level is considered a non-CNO availability due to the nature of the repair work and ship's assigned tasking. Intermediate-level maintenance consists of but is not limited to all organizational-level maintenance, installation of alterations (modifications), provision of services (i.e., power, gas, and specific tools), and technical assistance to ship's force in diagnosing and repair.

The highest maintenance level, depot-level maintenance, consists of maintenance that requires facilities and capabilities beyond the intermediate level and is performed by the public or private shipyards. Depot-level maintenance is promulgated by the CNO, and scheduled according to the ship-class specific maintenance plan (i.e., CVN 68 class). Depot-level maintenance periods are classified as a CNO availability, which consists of but is not limited to organizational- and intermediate-level maintenance, repair and modernization of the propulsion, electric, and auxiliary plants, and structural repairs (OPNAV N431 2010).

CNO Availability Planning Process

The planning phase for a CNO availability starts as far out as two years prior to the availability start date, with the initial issue of the Availability Work Package (AWP). The AWP consists of maintenance actions, known interchangeably as work items or jobs, and ship alterations identified by ship's force, NAVSEA, and other supporting engineering commands, known as codes. The initial AWP identifies the known work and class alterations that must be completed during the availability. Additional work items are identified and added to the AWP during work discovery periods scheduled during the planning phase. The discovery periods are conducted by ship's force with oversight and assists from the fleet support activities that specialize in pre-availability testing and ship deficiency identification.

Job summaries (JSs) are created for all work items in the AWP and are the fundamental planning elements that allow an availability's project schedule to be determined. A JS identifies the instructions relevant to the job; breaks down the required work necessary for job completion; and allows for the planning of resources and control of work during the execution phase. JSs are created by the engineering and planning codes and are then issued to the availability's management team for review. The review accounts for accuracies in skill designations, and sufficiency in durations and management ability. The JS review is an iterative process and continues until all required work and resources are approved and are written into Technical Work Documents (TWDs). Upon start of the availability and the execution phase, TWDs are issued to the Executing Activities, providing specific instructions on the work needing completion ("Baseline Project Management Plan," NAVSEA 07, 2009).

AVAILABILITY EXECUTION

Shipyard project managers continually track and update all in-progress jobs during an ongoing availability, with the goal of finishing the availability on time. The scheduling (planning phase) and maintaining (execution phase) of the AWP jobs is one of the most important activities to accomplish in the determination of how an availability's resources should be integrated, especially when multiple jobs during a single availability are executing in parallel (Kerzner 2009). Due to the high complexity of the AWP and tight schedule deadlines, project managers are challenged to solve problems rapidly, efficiently, and with minimal impact to separate on-going jobs. As a result, scheduling techniques have been developed which allow project managers to mitigate the effects of unplanned events that arise during availability execution. Network modeling and critical path analysis are essential for project managers to understand in order to reveal the interdependencies between the on-going jobs and to help managers evaluate alternatives by answering questions such as how time delays will affect the availability's completion (2009).

Work Stoppage

The term "work stoppage" is defined as a delay experienced by a job during the execution phase of the availability. Specifically, a work stoppage occurs when work on a job is delayed by more than one shift ("AIM-NG Process Manual," NAVSEA 04X, 2009). Work stoppages are categorized into eight reason codes (RSN):Technical Direction (TD)–awaiting engineering resolution or technical direction (i.e., NAVSEA approved instructions) for work continuation; Material (MAT)–delay in obtaining/receiving material; Tooling (TL)–delay due to limited quantity of tools and manufacturing support of new special tooling.; Labor Resources (RSC)–shortage of manpower and other support services; Work Control (WC)–administrative controls over system conditions needed to ensure safe work conditions are met prior to start of work; Workmanship/Rework (W)–delay due to rework; Interference/Coordination (IC)–delay due to multi-job priority levels, often due to space constraints and conditions; and Safety (SAF)–delay due to shipyard safety violation.

WebAIM Software

WebAIM-NG software is a project management tool, utilized for both planning and executing an availability, which assists the availability project team in planning, monitoring, and tracking all AWP jobs. This section describes the role of the software in the execution of shipyard availabilities.

Execution Priorities (EPR), as described in the *AIM-NG Process Manual*, is a logic process within the WebAIM software that develops and establishes shipyard priorities across all projects and availabilities within each shipyard. One of the main objectives of the EPR process is to identify on a daily basis the jobs that must be supported to maintain the non-stop execution of the critical chain in each availability. EPR tracks all activities and analyzes their impacts to the schedule. This is accomplished by evaluating activity durations, resource requirements, network sequencing, and known constraints in order to continually develop a list of priorities to aid the program manager in establishing a path forward. Depending in the daily impacts and the continual evaluation and identification of critical jobs by the EPR, the availability may have a continually changing critical path.

EPR color-codes all activities in order to bring attention to the critical work, prioritizing based on each activity's float, according to the following:Red activities have fewer than 10 shifts of float and are on or near the Critical Chain and completing Red activities late will likely prevent the project from meeting the key event associated with the activity; Yellow activities are the next-most-important selection of activities relative to completing events; and Green activities more than 30 shifts of float.

The color-coded activities are compiled and distributed into the Daily Priority List (DPL). The DPL lists the activities in priority number order, with the most critical activity needing support first. Availability teams use the DPL on a daily basis to identify the critical problems and develop/implement corrective actions with the goal of ensuring timely completion of work on of the critical chain.

EXECUTION DELAY ANALYSIS

The goal of this research is to summarize the work stoppage data to display commonalities between availabilities and to investigate possible trends in work stoppages and predictors of availability lateness. In order to identify associations between work stoppages and availability lateness, the analysis assumes that work stoppages are the only reason for schedule delays; no other factors and influences are considered.

Raw Work Stoppage Data

Work stoppage data are provided, in Microsoft Excel format. The data are collected from all four public shipyards and include all availabilities in which a work stoppage was submitted. The work stoppage data include the following categories, provided in Table 1 (NAVSEA 04X 2009).

Table 1. Work Stoppage Data Categories

Date	Month, year, and day the activity's work stoppage data was queried
Shipyard Priority Number	Assigned number to the work stoppage entry based on all ongoing work, across all platforms in shipyard. Priority number directly reflects the urgency of the item regarding its impact on the availability's critical chain
Project Identification	Three character alphanumeric code to classify availability identity
Job Identification Number	Alphanumeric code to identify specific activity
Start and Finish Dates	Dates in which the activity started and plans to finish. The finish date is updated to reflect delays
Reason Code	Eight work stoppage reasons
Color Code	Identifies activity criticality and impact to the availability's critical chain

The work stoppage data are a weekly look at all active work stoppages for all on-going availabilities. An active work stoppage is one in which a delay has been experienced in an activity and the administrative paper work has been submitted and is not yet resolved. Since work stoppages are continually submitted and cleared (resolved) on a daily basis, the collected work stoppage data does not account for every work stoppage experienced during an availability. This is due to the query rate. A query is conducted of the WebAIM software at the beginning of every week, usually every Monday; the results of this weekly query are displayed in the spreadsheet. In addition, the data provided does not give work stoppage submissions and clearing dates, preventing determination of work stoppage duration. Fortunately, duration can be roughly estimated based on the number of concurrent weeks a single work stoppage is observed. For example, if a work stoppage is observed once in the data set, it can be implied that its duration can be at least one day but no longer than 13 days. Similarly, if the same work stoppage, based on matching job numbers and reason codes, is present in the data for two consecutive weeks, then it can be assumed that its duration is at least eight days but no longer than 21 days. As a result of this large range of possible durations, the average of the extremities is assumed to be the work stoppage duration; an entry observed once is assumed to have a work stoppage duration of seven days, or one week. This data is analyzed for the purpose of identifying general trends on significant work stoppage delays.

Description Of The Data

The work stoppage data obtained covers approximately 18 months, between 24 May 2010 and 05 December 2011. During that time 32 availabilities had either started, completed, or both. Specifically, 14 availabilities had started prior to the collection window with nine of them finishing before the last collection date; 17 availabilities were still in-progress after the last collection date; and six availabilities had started and completed within the collection window.

Of the 32 availabilities, only the six availabilities that started and completed inside the data collection timeframe are used for the analysis of work stoppage. The availabilities that started prior to the collection timeframe are considered incomplete due to the unavailable work stoppage data prior to collection. The availabilities currently in progress are also determined to be incomplete because the outcomes, in regard to schedule duration and future work stoppage submittals, are unknown. Even though the current availabilities have estimated completion dates, unanticipated delays and future work stoppages may affect the end date, and therefore these availabilities are excluded from the analysis. Even though this criterion limits the availability's statistical population to a small sample size, it is the purpose of the criterion to only analyze complete and known availability data sets. The six availabilities for the work stoppage analysis are displayed in Table 2 and are considered the historical data for which trends and commonalities are investigated.

Table 2. Work Stoppage Analysis Availability Summary

Shipyard	Availability Type	Hull Type	Planned Length (Days)	Days Late (+) / Early(-)
NNSY	PIA	CVN	182	58
PSNSY	SRA	CVN	119	26
PHNSY	DSRA	SSN	177	19
PSNSY	MMP	SSGN	106	14
PSNSY	PIA	CVN	184	1
NNSY	CM	SSN	148	-5

Data Organization

The work stoppage data in its provided form contains individual entries of active work stoppages based on the query date. The current form is able to provide insight on the quantity of active work stoppages per query; however it does not adequately provide insight on entire work stoppage durations and job delays. Instead of manually sorting and compiling the original seventy thousand lines of work stoppage data, a Microsoft Excel macro, a customizable series of commands, is capable of efficiently sorting and compiling the data into the user's requested form. The data from the six availabilities is separated into six individual data files before the macro is run.

The Microsoft Excel macro is composed of an "if-then" statement that extracts the job identification number, work stoppage reason, and date from individual work stoppage entries. A comparison between two entries is performed to determine if the job identification number and work stoppage reason are the same, and if the entries are one week apart. One week is considered six, seven, or eight days to account for fluctuations in time between queries, due to days off for federal holidays. For this research, it is assumed that if a job is present on multiple consecutive weeks and it has the same work stoppage reason throughout, then that is considered a single work stoppage with the duration in weeks equal to the number of consecutive entries. If all three criterion are not met, the work stoppage entry is considered a single duration.

In order to quantify work stoppage durations, the length estimation discussed earlier is utilized. As stated, each work stoppage entry is estimated to have a duration range between one day and 13 days, with an average of seven days, or one week. This average of one week is taken as an assumption in which to classify a work stoppage entry. Similarly, a work stoppage with two or three consecutive entries is delayed two or three weeks, respectively. This assumption may not be precise in terms of actual duration, however it can provide general information on trends and commonalities.

The analysis further assumes that all jobs within the availability are executed according to the planned duration. Availability planning data, which includes the planned (estimated) job durations and the network diagram of sequential and concurrent jobs, is not available for analysis and therefore the planning durations must be assumed to be accurate. In part, it is further assumed that if a job is delayed and will not meet the planned completion date, a work stoppage has been submitted to document the delay.

Work Stoppages By Length

Each of the six availabilities is split into two data sets. The first data set includes all the work stoppage data, regardless of the color-coded criticality. These data allow for the identification of any significant factors causing availability lateness as it relates to the overall execution of the availability. The second data set includes only the work stoppages on or near the critical path, identified as "red" in the entry's color code. The EPR suggests failure to act on a "red" labeled work stoppage will likely result in missing an important milestone or key event. As a result, the identified critical work stoppages are analyzed separately.

Each data set is organized based on work stoppage reason and by duration. This organization allows the mean duration length, standard deviation, and standard error of the mean to be determined for each work stoppage reason.

Complete Work Stoppage Data

The mean lengths of work stoppages for each reason are displayed in Table 3. Standard errors of the means are displayed in the Appendix A. The six availabilities are sorted in descending order of lateness with the expectation of observing higher mean work stoppage lengths associated with the later availabilities.

availability's total work stoppages (Total WS in Table 3) results in the failure to reject the null hypothesis. This result may signify that lengths per work stoppage reason are not a factor in availability lateness, since the compared availabilities differ significantly on number of days late but do not differ based on mean length. Although it would be nice to rule out work stoppage lengths as a contributor to lateness, the method of work stoppage length estimation is surely an error contributor. The criticality of the work stoppages may also be a factor in explaining the failure in finding an association. This data is composed of work stoppages both on (red color-coded) and off (green and yellow color-coded) the critical chain and therefore the less critical work stoppages may be influencing the mean lengths of the work stoppage reasons. This hypothesis is further considered in the statistics analysis section of red color-coded work stoppages.

Although these data do not show availability lateness association, they do describe the dynamic of each availability with respect to work stoppages. By ranking each work stoppage reason's mean length relative to the other reasons within the same availability, it is concluded that resource work stoppages (RSC) are continually in the lower half of the rankings, signifying a shorter mean stoppage length. Conversely, interference/coordination work stoppages (IC) are in the top three, signifying some of the longest mean delays, five out six times.

Table 3. Work Stoppage Reason Mean Length Summary

Mean Length of Work Stoppage Duration (weeks)	Work Stoppage Reason: MAT	IC	TD	TL	SAF	W	WC	RSC	Total WS
CVN PIA 1 (58 Days Late)	2.06	2.12	1.84	1.00	1.53	2.00	2.35	1.84	1.99
CVN SRA 1 (26 Days Late)	1.83	1.24	1.50	2.50	1.00	2.20	1.57	1.33	1.65
SSN DSRA 1 (19 Days Late)	1.40	1.86	1.41	1.39	0.00	1.50	1.77	1.29	1.56
SSGN MMP 1 (14 Days Late)	1.61	1.70	1.60	2.00	2.00	0.00	1.50	1.60	1.66
CVN PIA 2 (1 Days Late)	1.88	2.18	1.76	1.36	2.00	3.00	2.20	1.67	1.97
SSN CM 1 (5 Days Early)	1.09	1.34	1.24	0.00	0.00	1.50	1.50	1.00	1.26

Unfortunately, no apparent simple association between mean length per work stoppage reason and availability lateness can be made.

Due the high variety and limited replications of hull and availability types in the sample, the influence of these factors as it relates to average work stoppage length cannot be determined. In order to provide some insight, a comparison is conducted between the CVN PIA 1 and the CVN PIA 2, similar hull and availability type, using a student t-test with the null hypothesis stating the difference between the mean lengths of all work stoppages is zero. Comparing the mean length of the

Red Color-Coded Work Stoppage Data

The red color-coded work stoppages are organized in the same fashion as the complete data set, and similarly, there is no apparent simple association between availability lateness and average work stoppage length. The same student t-test is performed, comparing total work stoppage mean length between the CVN 1 and CVN 2 PIAs, and again results in the failure to reject the null hypothesis that the work stoppage mean lengths are the same.

The average length and the standard deviation (not shown but displayed in the Appendix A) of the red-color coded data are smaller than the complete data set's average length and standard deviation. The smaller values represent a shorter mean delay and a tighter empirical distribution of lengths. As the highest prioritized jobs, the red coded work stoppages are better supported and the delays are quickly resolved to ensure continuous flow of the critical chain. This is attributed to the Daily Priority List (DPL) and the project team's continual focus on the list.

Ordering the reasons for work stoppages using mean lengths of the stoppages results in interference/coordination as well as work control (WC) stoppages being ranked in the top two positions, signifying longest mean length, in over half of the availabilities analyzed, and in the top 50% of the rankings five of six times. These are the largest groupings observed and are worth noting.

Work Stoppages by Quantity

Each of the eight reasons' total number of work stoppages is tallied and the percent of the availability's total work stoppages for each reason is calculated. The tallied quantities for both complete and red color-coded data sets are displayed in Appendix A. Although no direct association is observed between percentage of work stoppages by reason and availability lateness, material (MAT), interference/coordination, and technical direction (TD) are consistently the three highest percentages for which red color-coded work stoppages are experienced. Similar percentages are observed in the complete work stoppage data set, with the same three work stoppage reasons having the highest percentages.

Work Stoppage By Time-In-Availability

As an availability progresses from the planning and preparation phase, to the execution phase, and finally to the testing phase, the management team's focus is always shifting. The framework of the planning phase is known as the left-to-right sweep. This sweep aims to ensure all lessons learned and best practices from past and ongoing availabilities are incorporated into the planning process (NAVSEA 07 2009). During this phase, the support work (to include prefabrication and manufacturing work) is the focus to ensure the infrastructure and support services are ready for the execution phase. The execution phase is where the majority of the production work, known in the shipyard industry as "wrench turning," takes place. The focus of the execution phase is to ensure the continuous forward movement of the work package jobs through the prioritization of jobs. The testing phase occurs at the end of the availability, with the focus of assessing the quality of the work performed.

The change in phases may be reflected in changes in reasons for work stoppages. The work stoppage data for the six availabilities is organized based on time-in-availability that the work stoppage occurred with the intent to observe the shifts in the focuses, as well as to identify any associations between work stoppages and availability lateness. Each availability is divided into three time segments: time before the start of the availability, the planned duration, and the time after the planned completion date of the availability. The planned availability duration is further segmented into tenths. The work stoppage data starts being collected eight weeks prior to availability start; support work normally starts during this eight week period. The planned availability duration (availability's planned completion date minus start date) is split into tenths to account for the difference in availability lengths and to allow for comparison on the same time scale. The work stoppages are organized by reason and by the time they are experienced during the availability. This time is determined based upon the availability's start date and the query date of the work stoppage entry. The complete and red color-coded data sets organized by time-in-availability are displayed in the Appendix B.

Figure 1 displays the number of work stoppages by reason for the SSN DSRA 1 as a function of time of occurrence during its availability. The shift in the focus from the planning and preparation phase to the execution phase is observed in the changing numbers of work stoppages due to different reasons.

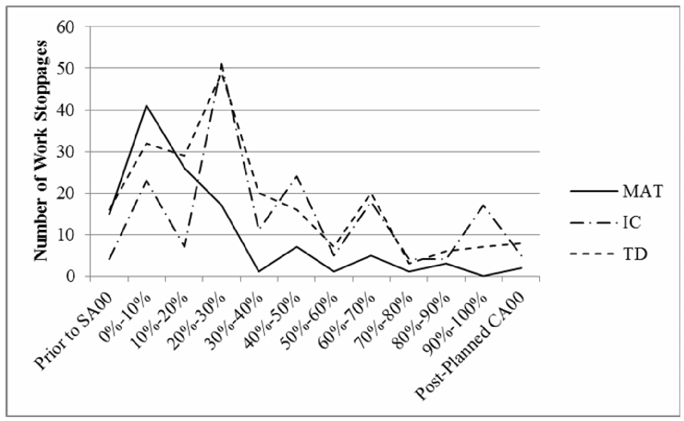

Fig. 1. Quantity of MAT, IC, and TD Work Stoppages by Time-in-Availability

Prior to the start of the SSN DSRA 1, material and technical direction work stoppages are responsible for the largest numbers of delays. This can be attributed to the support and prefabrication work being performed before the production work commences. During the first 30% of the availability, there is a gradual decrease in material work stoppages and a rapid increase in interference/coordination stoppages. This is due to the focus shift from planning/preparation to execution, where production work is on the rise and the on-going jobs are interfering with one another. At this point in the availability, the management team must prioritize jobs and assign precedence in order to keep work moving. The shift in focus to execution is further amplified by the continual increase in technical direction work stoppages, with the bulk of these experienced during the first 30% of the availability.

The complete data set of the SSN DSRA 1 provides the clearest example of observing this shift. Although the shift from planning to execution is not visually apparent in every availability, the number of interference/coordination work stoppages in all six of the analyzed availabilities tend to be small at the beginning and end of the availability and with the majority located in 30%–70% range of the availability.

Pre-availability Work Stoppage Ratio

Comparison of the number of work stoppages experienced prior to availability start and the number of work stoppages experienced during the execution phase in the complete data set suggests that availabilities that are close to completing on-time experience a relatively smaller number of work stoppages before the availability starts than during it. As a result of this suggestion, ratios are calculated by dividing the number of work stoppages experienced prior to the start of the availability by the total number of work stoppages experienced up until to the desired point in time during the availability. For example, to calculate this pre-availability work stoppage ratio for the first 50% of the availability, the number of work stoppages prior to availability start is divided by the sum of the total number of work stoppages experienced up until the 50% point, to include the work stoppages prior to the availability start. The ratio (in percentage form) for all availabilities is displayed in the Appendix B.

Beginning at the 50% point in the availability and onward, a trend is observed with the higher percentages of pre-availability work stoppages associated with the later finishing availabilities.

Figure 2 is an example of the pre-availability ratio for the 50%point of the availability length versus their respective number of days late. Similar trend lines are observed at the 60%, 70%, 80%, 90%, 100%, and the post-planned completion date.

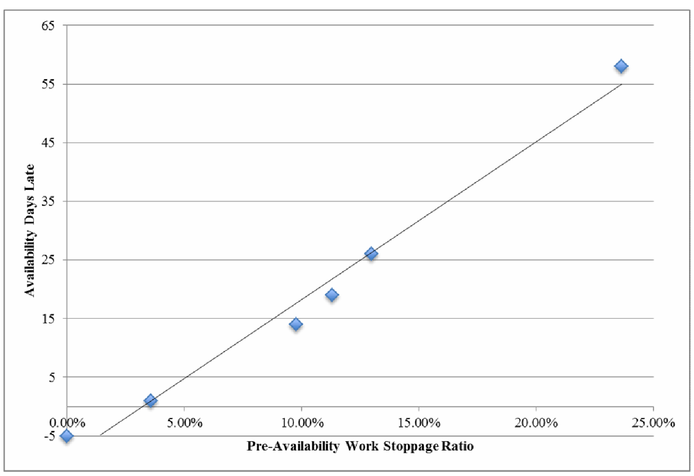

Fig. 2. Pre-Availability Work Stoppage Ratio at 50% Point of Planned Availability

The approximate linear relationship displayed in Figure 2 provides the first indication of a positive association between numbers of work stoppages and availability lateness.The association is attributed to the number of work stoppages experienced during the planning/preparation phase as compared to the execution phase of the availability; the more work stoppages that are experienced during the planning/preparation phase, the more likely the availability will not be completed on time. This association, while it may provide information on availability lateness, must be understood with two caveats. The first is of course the limited amount of provided data.

A similar comparison with a data set containing the true number of work stoppages is recommended for association validation. Secondly, consistency is maintained by starting data collection eight weeks prior to the availability start; however, without any additional information on the length of the planning phases, it can only be assumed that all planning phases and availability preparations were conducted during similar lengths of time.

It can further be assumed without any additional information on the planning and execution phases of these historical availabilities, that delays experienced prior to the start of an availability, during the planning phase, affect the ability of the execution phase to be carried out as planned.

This seems plausible since the majority of the work accomplished prior to the start of the availability is in preparation for the future production work. If these supporting jobs are not ready at the start of the availability, jobs in the execution phase will be missing the supportive infrastructure required for completion.

CONCLUSION

The work stoppage analysis investigates the interactions and effects of delays during an execution of an availability. Although the provided work stoppage data is only a weekly snapshot of the number, reason, and duration of work stoppages submitted, trends with respect to availability lateness and commonalities between all types of availabilities are discovered. The collection of work stoppage data is composed weekly of work stoppage entries between 24 May 2010 and 05 Dec 2011. Each entry is compared to one another in order to group similar entries in terms of job number and work stoppage reason. This organization method is the foundation for the work stoppage research and allows for the analysis to examine work stoppages in terms of the work stoppage lengths, quantities, and time-in-availability.

No Association between Quantity or Length of Work Stoppage and Availability Lateness

The conjecture at the beginning of this analysis is that larger work stoppage lengths and larger numbers of work stoppage would be associated with the late running availabilities. Unfortunately, neither the mean length per work stoppage reason nor the total number of work stoppages appear associated with availability lateness. The small sample size of sixavailabilities may contribute to this finding. A better understanding of the work stoppages' effect on availability lateness can be accomplished if all work stoppage data is recorded; that is, all submitted work stoppages are recorded, accompanied by the true durations, and the availability's WebAIM schedule is provided. This information, when analyzed simultaneously, will allow for the work stoppage's impact on the schedule's float to be better quantified.

Although the number and mean length of work stoppages is not associated with availability lateness, the analysis did show material, interference/coordination, and technical direction are the most likely reasons for work stoppage. From an availability manager's perspective with the goal of minimizing delays, this analysis offers the following recommendation: ensure that material lead times are proactively managed and the planning of work item integration and scheduling is highly detailed and thorough.

On-Time Availabilities Have Relatively Smaller Numbers of Work Stoppages Prior to Availability Start

A display of the number of work stoppages occurring by time-in-availability suggests that on-time availabilities tend toexperience smaller numbers of work stoppages prior to the start of the availability. Correspondingly, the late finishing availabilities tend to experience higher numbers of work stoppages prior to and during the early stages of the availability. Furthermore, organizing work stoppages by occurrence time-in-availability results in an approximate linear association between availability days late and the ratio of work stoppages experienced prior to the availability start to the total number of work stoppages experienced during the entire availability. This ratio, in percentage form, is larger for the later availabilities, signifying a higher number of work stoppages prior to availability start than during it, compared to the on-time availabilities. This finding is based on data from six completed availabilities and should be further examined using data from additional availabilities.

However, even with the limited data, this association introduces the question as to why work stoppages experienced prior to the start of the availability affect the outcome of the availability. Without any additional knowledge as to the planning and execution phases of the analyzed availabilities, it is presumed that the work stoppages prior to the availability start are associated with the support and prefabrication work that takes place in preparation for the availability's execution. As a result of the delay in the preparation work, the production work planned during the execution phase may not have the required support services in place to execute on time.

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APPENDIX A – WORK STOPPAGE BY LENGTH

Table A1. CVN PIA 1 Complete Data

Duration (weeks)	Work Stoppage Reason: MAT	IC	TD	TL	SAF	W	WC	RSC	Total WS
1	379	423	479	16	61	33	55	94	1540
2	142	186	150	0	1	9	22	36	546
3	49	86	77	0	2	3	20	15	252
4	36	53	35	0	1	4	6	8	143
5	19	26	8	0	0	0	2	1	56
6	21	14	14	0	3	3	1	3	59
7	12	11	5	0	1	0	2	3	34
8	2	4	5	0	0	0	1	0	12
9	5	5	6	0	1	0	0	1	18
10	3	3	0	0	0	0	1	0	7
11	0	2	3	0	0	0	2	0	7
12	0	1	0	0	0	1	0	0	2
13	0	0	0	0	0	0	1	0	1
14	0	1	0	0	0	0	0	0	1
15	1	0	0	0	0	0	0	0	1
16	1	1	0	0	0	0	0	0	2
Total	670	816	782	16	70	53	113	161	2681
Mean Length of Stoppage (weeks)	2.06	2.12	1.84	1.00	1.53	2.00	2.35	1.84	1.99
Standard Deviation	1.83	1.79	1.52	0.00	1.57	1.94	2.21	1.40	1.73
Standard Error of Mean	0.07	0.06	0.05	0.00	0.19	0.27	0.21	0.11	0.03

Table A2. CVN PIA 1 Red Color-Coded Data

Duration (weeks)	Work Stoppage Reason: MAT	IC	TD	TL	SAF	W	WC	RSC	Total WS
1	135	147	121	2	9	9	27	25	475
2	32	45	25	0	0	0	4	8	114
3	6	14	9	0	0	0	3	1	33
4	1	7	2	0	0	0	1	0	11
5	2	2	0	0	0	0	0	0	4
6	0	0	1	0	0	0	0	0	1
7	1	1	0	0	0	0	0	0	2
8	0	0	0	0	0	0	0	0	0
9	0	0	0	0	0	0	0	0	0
10	0	0	0	0	0	0	0	0	0
11	0	0	0	0	0	0	0	0	0
12	0	1	0	0	0	0	0	0	1
Total	177	217	158	2	9	9	35	34	641
Mean Length of Stoppage (weeks)	1.34	1.55	1.34	1.00	1.00	1.00	1.37	1.29	1.40
Standard Deviation	0.80	1.15	0.74	0.00	0.00	0.00	0.76	0.52	0.90
Standard Error of Mean	0.06	0.08	0.06	0.00	0.00	0.00	0.13	0.09	0.04

Table A3. CVN SRA 1 Complete Data

Work Stoppage Reason

Duration (weeks)	MAT	IC	TD	TL	SAF	W	WC	RSC	Total WS
1	71	17	86	1	1	5	9	4	194
2	23	3	19	0	0	3	3	2	53
3	11	1	8	0	0	0	1	0	21
4	6	0	5	1	0	0	1	0	13
5	5	0	1	0	0	1	0	0	7
6	2	0	0	0	0	1	0	0	3
7	1	0	1	0	0	0	0	0	2
8	0	0	0	0	0	0	0	0	0
9	0	0	0	0	0	0	0	0	0
10	0	0	0	0	0	0	0	0	0
11	0	0	0	0	0	0	0	0	0
12	0	0	0	0	0	0	0	0	0
13	0	0	0	0	0	0	0	0	0
14	0	0	0	0	0	0	0	0	0
15	0	0	0	0	0	0	0	0	0
16	0	0	0	0	0	0	0	0	0
Total	119	21	120	2	1	10	14	6	293
Mean Length of Stoppage (weeks)	1.83	1.24	1.50	2.50	1.00	2.20	1.57	1.33	1.65
Standard Deviation	1.31	0.53	0.99	1.50	0.00	1.72	0.90	0.47	1.16
Standard Error of Mean	0.12	0.11	0.09	1.06	0.00	0.54	0.24	0.19	0.07

Table A4. CVN SRA 1 Red Color-Coded Data

Work Stoppage Reason

Duration (weeks)	MAT	IC	TD	TL	SAF	W	WC	RSC	Total WS
1	24	8	25	0	1	2	5	2	67
2	6	1	6	0	0	1	1	1	16
3	2	1	0	0	0	0	1	0	4
4	1	0	0	0	0	0	0	0	1
5	0	0	0	0	0	0	0	0	0
6	0	0	0	0	0	0	0	0	0
7	0	0	0	0	0	0	0	0	0
8	0	0	0	0	0	0	0	0	0
9	0	0	0	0	0	0	0	0	0
10	0	0	0	0	0	0	0	0	0
11	0	0	0	0	0	0	0	0	0
12	0	0	0	0	0	0	0	0	0
Total	33	10	31	0	1	3	7	3	88
Mean Length of Stoppage (weeks)	1.39	1.30	1.19	0.00	1.00	1.33	1.43	1.33	1.31
Standard Deviation	0.74	0.64	0.40	0.00	0.00	0.47	0.73	0.47	0.61
Standard Error of Mean	0.13	0.20	0.07	0.00	0.00	0.27	0.28	0.27	0.06

Table A5. SSN DSRA 1 Complete Data

Work Stoppage Reason

Duration (weeks)	MAT	IC	TD	TL	SAF	W	WC	RSC	Total WS
1	81	94	156	12	0	1	21	19	384
2	31	41	36	5	0	1	4	3	121
3	5	21	16	1	0	0	2	2	47
4	1	9	2	0	0	0	2	0	14
5	1	6	1	0	0	0	0	0	8
6	0	0	2	0	0	0	0	0	2
7	0	0	0	0	0	0	0	0	0
8	0	1	0	0	0	0	0	0	1
9	0	1	0	0	0	0	0	0	1
10	0	0	0	0	0	0	1	0	1
11	0	0	0	0	0	0	0	0	0
12	0	0	0	0	0	0	0	0	0
13	0	0	0	0	0	0	0	0	0
14	0	0	0	0	0	0	0	0	0
15	0	0	0	0	0	0	0	0	0
16	0	0	0	0	0	0	0	0	0
Total	119	173	213	18	0	2	30	24	579
Mean Length of Stoppage (weeks)	1.40	1.86	1.41	1.39	0.00	1.50	1.77	1.29	1.56
Standard Deviation	0.69	1.29	0.83	0.59	0.00	0.50	1.76	0.61	1.04
Standard Error of Mean	0.06	0.10	0.06	0.14	0.00	0.35	0.32	0.12	0.04

Table A6. SSN DSRA 1 Red Color-Coded Data

Work Stoppage Reason

Duration (weeks)	MAT	IC	TD	TL	SAF	W	WC	RSC	Total WS
1	26	63	68	3	0	1	8	12	181
2	5	16	3	1	0	0	5	0	30
3	1	5	1	1	0	0	2	1	11
4	0	2	0	0	0	0	2	0	4
5	0	2	0	0	0	0	0	0	2
6	0	0	0	0	0	0	0	0	0
7	0	0	0	0	0	0	0	0	0
8	0	0	0	0	0	0	0	0	0
9	0	0	0	0	0	0	0	0	0
10	0	0	0	0	0	0	0	0	0
11	0	0	0	0	0	0	0	0	0
12	0	0	0	0	0	0	0	0	0
Total	32	88	72	5	0	1	17	13	228
Mean Length of Stoppage (weeks)	1.22	1.45	1.07	1.60	0.00	1.00	1.88	1.15	1.32
Standard Deviation	0.48	0.88	0.30	0.80	0.00	0.00	1.02	0.53	0.72
Standard Error of Mean	0.09	0.09	0.04	0.36	0.00	0.00	0.25	0.15	0.05

Table A7. SSGN MMP 1 Complete Data

Work Stoppage Reason

Duration (weeks)	MAT	IC	TD	TL	SAF	W	WC	RSC	Total WS
1	66	89	18	0	1	0	4	4	182
2	21	37	6	1	0	0	1	0	66
3	7	10	6	0	1	0	1	0	25
4	2	9	0	0	0	0	0	1	12
5	4	2	0	0	0	0	0	0	6
6	1	0	0	0	0	0	0	0	1
7	0	1	0	0	0	0	0	0	1
8	0	1	0	0	0	0	0	0	1
9	0	0	0	0	0	0	0	0	0
10	0	0	0	0	0	0	0	0	0
11	0	0	0	0	0	0	0	0	0
12	0	0	0	0	0	0	0	0	0
13	0	0	0	0	0	0	0	0	0
14	0	0	0	0	0	0	0	0	0
15	0	0	0	0	0	0	0	0	0
16	0	0	0	0	0	0	0	0	0
Total	101	149	30	1	2	0	6	5	294
Mean Length of Stoppage (weeks)	1.61	1.70	1.60	2.00	2.00	0.00	1.50	1.60	1.66
Standard Deviation	1.08	1.16	0.80	0.00	1.00	0.00	0.76	1.20	1.09
Standard Error of Mean	0.11	0.10	0.15	0.00	0.71	0.00	0.31	0.54	0.06

Table A8. SSGN MMP 1 Red Color-Coded Data

Work Stoppage Reason

Duration (weeks)	MAT	IC	TD	TL	SAF	W	WC	RSC	Total WS
1	48	70	11	0	2	0	3	4	138
2	13	22	1	1	0	0	0	0	37
3	1	4	1	0	0	0	0	0	6
4	1	5	0	0	0	0	0	0	6
5	2	0	0	0	0	0	0	0	2
6	1	0	0	0	0	0	0	0	1
7	0	2	0	0	0	0	0	0	2
8	0	0	0	0	0	0	0	0	0
9	0	0	0	0	0	0	0	0	0
10	0	0	0	0	0	0	0	0	0
11	0	0	0	0	0	0	0	0	0
12	0	0	0	0	0	0	0	0	0
Total	66	103	13	1	2	0	3	4	192
Mean Length of Stoppage (weeks)	1.47	1.55	1.23	2.00	1.00	0.00	1.00	1.00	1.48
Standard Deviation	1.02	1.09	0.58	0.00	0.00	0.00	0.00	0.00	1.02
Standard Error of Mean	0.13	0.11	0.16	0.00	0.00	0.00	0.00	0.00	0.07

Table A9. CVN PIA 2 Complete Data

Work Stoppage Reason

Duration (weeks)		MAT	IC	TD	TL	SAF	W	WC	RSC	Total WS
	1	166	257	187	12	4	4	24	81	735
	2	94	128	70	1	0	8	13	38	352
	3	46	66	25	0	0	1	1	10	149
	4	16	32	15	0	0	0	1	5	69
	5	5	22	3	1	0	0	0	1	32
	6	4	14	5	0	1	0	1	2	27
	7	1	7	3	0	0	0	1	1	13
	8	1	2	1	0	0	0	1	0	5
	9	1	2	1	0	0	1	1	0	6
	10	0	4	0	0	0	0	1	0	5
	11	0	0	0	0	0	0	0	0	0
	12	0	1	0	0	0	0	0	0	1
	13	0	0	0	0	0	1	0	0	1
	14	0	0	0	0	0	0	0	0	0
	15	0	0	0	0	0	0	0	0	0
	16	0	0	0	0	0	0	0	0	0
	Total	334	535	310	14	5	15	44	138	1395
Mean Length of Stoppage (weeks)		1.88	2.18	1.76	1.36	2.00	3.00	2.20	1.67	1.97
Standard Deviation		1.21	1.71	1.30	1.04	2.00	3.27	2.22	1.08	1.52
Standard Error of Mean		0.07	0.07	0.07	0.28	0.89	0.84	0.33	0.09	0.04

Table A10. CVN PIA 2 Red Color-Coded Data

Work Stoppage Reason

Duration (weeks)		MAT	IC	TD	TL	SAF	W	WC	RSC	Total WS
	1	40	76	33	2	0	3	11	4	169
	2	9	18	4	0	0	1	1	3	36
	3	1	11	0	0	0	0	0	0	12
	4	0	3	0	0	0	0	1	0	4
	5	0	2	1	0	0	0	1	0	4
	6	0	0	0	0	0	0	0	0	0
	7	0	0	0	0	0	0	0	0	0
	8	0	0	0	0	0	0	0	0	0
	9	0	1	0	0	0	0	0	0	1
	10	0	0	0	0	0	0	0	0	0
	11	0	0	0	0	0	0	0	0	0
	12	0	0	0	0	0	0	0	0	0
	Total	50	111	38	2	0	4	14	7	226
Mean Length of Stoppage (weeks)		1.22	1.59	1.21	1.00	0.00	1.25	1.57	1.43	1.42
Standard Deviation		0.46	1.15	0.69	0.00	0.00	0.43	1.24	0.49	0.96
Standard Error of Mean		0.07	0.11	0.11	0.00	0.00	0.22	0.33	0.19	0.06

Table A11. SSN CM 1 Complete Data

Work Stoppage Reason

Duration (weeks)	MAT	IC	TD	TL	SAF	W	WC	RSC	Total WS
1	29	40	23	0	0	5	1	2	100
2	3	5	0	0	0	0	1	0	9
3	0	3	1	0	0	0	0	0	4
4	0	2	0	0	0	1	0	0	3
5	0	0	1	0	0	0	0	0	1
6	0	0	0	0	0	0	0	0	0
7	0	0	0	0	0	0	0	0	0
8	0	0	0	0	0	0	0	0	0
9	0	0	0	0	0	0	0	0	0
10	0	0	0	0	0	0	0	0	0
11	0	0	0	0	0	0	0	0	0
12	0	0	0	0	0	0	0	0	0
13	0	0	0	0	0	0	0	0	0
14	0	0	0	0	0	0	0	0	0
15	0	0	0	0	0	0	0	0	0
16	0	0	0	0	0	0	0	0	0
Total	32	50	25	0	0	6	2	2	117
Mean Length of Stoppage (weeks)	1.09	1.34	1.24	0.00	0.00	1.50	1.50	1.00	1.26
Standard Deviation	0.29	0.76	0.86	0.00	0.00	1.12	0.50	0.00	0.72
Standard Error of Mean	0.05	0.11	0.17	0.00	0.00	0.46	0.35	0.00	0.07

Table A12. SSN CM 1 Red Color-Coded Data

Work Stoppage Reason

Duration (weeks)	MAT	IC	TD	TL	SAF	W	WC	RSC	Total WS
1	13	24	13	0	0	2	2	2	56
2	0	3	0	0	0	1	0	0	4
3	0	3	1	0	0	0	0	0	4
4	0	0	0	0	0	0	0	0	0
5	0	0	0	0	0	0	0	0	0
6	0	0	0	0	0	0	0	0	0
7	0	0	0	0	0	0	0	0	0
8	0	0	0	0	0	0	0	0	0
9	0	0	0	0	0	0	0	0	0
10	0	0	0	0	0	0	0	0	0
11	0	0	0	0	0	0	0	0	0
12	0	0	0	0	0	0	0	0	0
Total	13	30	14	0	0	3	2	2	64
Mean Length of Stoppage (weeks)	1.00	1.30	1.14	0.00	0.00	1.33	1.00	1.00	1.19
Standard Deviation	0.00	0.64	0.52	0.00	0.00	0.47	0.00	0.00	0.53
Standard Error of Mean	0.00	0.12	0.14	0.00	0.00	0.27	0.00	0.00	0.07

APPENDIX B – WORK STOPPAGE BY TIME IN AVAILABILITY

Table B1. CVN PIA 1 Complete Data

Percentage of Planned Duration	Work Stoppage Reason: MAT	IC	TD	TL	SAF	W	WC	RSC	Total WS
Prior to SA00	123	21	197	0	0	0	4	1	346
0%-10%	30	73	56	1	2	2	2	12	178
10%-20%	45	29	77	1	1	0	8	5	166
20%-30%	61	79	72	2	0	5	3	19	241
30%-40%	50	62	83	1	52	1	15	34	298
40%-50%	41	84	70	0	2	2	7	29	235
50%-60%	36	121	50	8	0	10	10	19	254
60%-70%	104	139	90	2	0	7	24	25	391
70%-80%	52	78	31	0	3	1	7	10	182
80%-90%	62	81	40	0	1	4	14	5	207
90%-100%	15	18	4	1	1	9	4	1	53
Post-Planned CA00	51	31	12	0	8	12	15	1	130

Table B2. CVN PIA 1 Red Color-Coded Data

Percentage of Planned Duration	Work Stoppage Reason: MAT	IC	TD	TL	SAF	W	WC	RSC	Total WS
Prior to SA00	24	8	36	0	0	0	0	0	68
0%-10%	5	4	2	0	0	1	0	1	13
10%-20%	7	3	9	0	0	0	0	0	19
20%-30%	10	8	4	0	0	0	1	2	25
30%-40%	7	23	13	0	9	0	1	6	59
40%-50%	6	20	4	0	0	0	1	6	37
50%-60%	9	20	30	2	0	1	1	9	72
60%-70%	22	55	15	0	0	0	2	2	96
70%-80%	24	29	18	0	0	0	2	5	78
80%-90%	31	25	16	0	0	2	9	3	86
90%-100%	2	6	1	0	0	1	3	0	13
Post-Planned CA00	30	16	10	0	0	4	15	0	75

Table B3. CVN SRA 1 Complete Data

	Work Stoppage Reason								
Percentage of Planned Duration	MAT	IC	TD	TL	SAF	W	WC	RSC	Total
Prior to SA00	11	3	13	0	0	0	0	1	28
0%-10%	9	2	5	0	0	0	1	1	18
10%-20%	11	2	12	0	0	0	0	1	26
20%-30%	20	10	28	1	1	3	2	1	66
30%-40%	14	0	17	0	0	0	0	1	32
40%-50%	21	3	14	1	0	2	3	1	45
50%-60%	14	0	12	0	0	3	2	0	31
60%-70%	1	0	0	0	0	0	0	0	1
70%-80%	8	0	5	0	0	2	0	0	15
80%-90%	1	0	2	0	0	0	1	0	4
90%-100%	1	0	5	0	0	0	2	0	8
Post-Planned CA00	8	1	7	0	0	0	3	0	19

Table B4. CVN SRA 1 Red Color-Coded Data

	Work Stoppage Reason								
Percentage of Planned Duration	MAT	IC	TD	TL	SAF	W	WC	RSC	Total WS
Prior to SA00	5	3	4	0	0	0	0	1	13
0%-10%	1	0	1	0	0	0	0	0	2
10%-20%	0	1	4	0	0	0	0	0	5
20%-30%	5	5	4	0	1	3	1	1	20
30%-40%	3	0	2	0	0	0	0	1	6
40%-50%	5	1	4	0	0	0	2	0	12
50%-60%	7	0	9	0	0	0	1	0	17
60%-70%	0	0	0	0	0	0	0	0	0
70%-80%	1	0	0	0	0	0	0	0	1
80%-90%	0	0	0	0	0	0	0	0	0
90%-100%	0	0	0	0	0	0	0	0	0
Post-Planned CA00	6	0	3	0	0	0	3	0	12

Table B5. SSN DSRA 1 Complete Data

	Work Stoppage Reason								
Percentage of Planned Duration	MAT	IC	TD	TL	SAF	W	WC	RSC	Total
Prior to SA00	15	4	16	3	0	0	11	2	51
0%-10%	41	23	32	7	0	1	6	4	114
10%-20%	26	7	29	1	0	0	0	0	63
20%-30%	17	51	49	3	0	1	4	3	128
30%-40%	1	11	20	1	0	0	0	4	37
40%-50%	7	24	16	3	0	0	4	3	57
50%-60%	1	5	7	0	0	0	0	0	13
60%-70%	5	18	20	0	0	0	2	5	50
70%-80%	1	4	3	0	0	0	0	1	9
80%-90%	3	4	6	0	0	0	2	0	15
90%-100%	0	17	7	0	0	0	1	1	26
Post-Planned CA00	2	5	8	0	0	0	0	1	16

Table B6. SSN DSRA 1 Red Color-Coded Data

	Work Stoppage Reason								
Percentage of Planned Duration	MAT	IC	TD	TL	SAF	W	WC	RSC	Total WS
Prior to SA00	4	2	4	0	0	0	3	0	13
0%-10%	6	6	5	1	0	0	2	2	22
10%-20%	4	4	4	0	0	0	0	0	12
20%-30%	8	15	18	0	0	1	3	1	46
30%-40%	0	4	5	1	0	0	0	1	11
40%-50%	4	13	6	3	0	0	4	2	32
50%-60%	2	4	1	0	0	0	0	0	7
60%-70%	1	11	12	0	0	0	3	5	32
70%-80%	0	4	0	0	0	0	0	0	4
80%-90%	1	2	2	0	0	0	1	0	6
90%-100%	0	18	7	0	0	0	1	1	27
Post-Planned CA00	2	5	8	0	0	0	0	1	16

Table B7. SSGN MMP 1 Complete Data

Percentage of Planned Duration	Work Stoppage Reason: MAT	IC	TD	TL	SAF	W	WC	RSC	Total
Prior to SA00	10	2	4	0	0	0	0	0	16
0%-10%	1	0	0	0	0	0	0	0	1
10%-20%	15	7	3	0	0	0	2	1	28
20%-30%	1	6	4	0	0	0	0	0	11
30%-40%	12	34	8	0	1	0	2	1	58
40%-50%	21	20	5	1	0	0	1	1	49
50%-60%	16	26	3	0	0	0	0	2	47
60%-70%	7	24	1	0	1	0	1	0	34
70%-80%	15	10	2	0	0	0	0	0	27
80%-90%	1	2	0	0	0	0	0	0	3
90%-100%	1	12	0	0	0	0	0	0	13
Post-Planned CA00	1	6	0	0	0	0	0	0	7

Table B8. SSGN MMP 1 Red Color-Coded Data

Percentage of Planned Duration	Work Stoppage Reason: MAT	IC	TD	TL	SAF	W	WC	RSC	Total WS
Prior to SA00	6	1	1	0	0	0	0	0	8
0%-10%	0	0	0	0	0	0	0	0	0
10%-20%	5	4	2	0	0	0	1	1	13
20%-30%	1	3	1	0	0	0	0	0	5
30%-40%	4	20	1	0	0	0	0	1	26
40%-50%	18	10	3	1	0	0	1	0	33
50%-60%	14	30	3	0	1	0	0	2	50
60%-70%	6	11	1	0	1	0	1	0	20
70%-80%	10	4	1	0	0	0	0	0	15
80%-90%	0	1	0	0	0	0	0	0	1
90%-100%	1	13	0	0	0	0	0	0	14
Post-Planned CA00	1	6	0	0	0	0	0	0	7

Table B9. CVN PIA 2 Complete Data

Work Stoppage Reason

Percentage of Planned Duration	MAT	IC	TD	TL	SAF	W	WC	RSC	Total
Prior to SA00	4	0	12	0	0	1	7	7	31
0%-10%	13	19	27	0	0	0	10	8	77
10%-20%	32	48	40	2	1	0	1	16	140
20%-30%	21	62	38	1	1	2	1	20	146
30%-40%	47	62	54	4	2	1	3	26	199
40%-50%	61	126	51	2	1	5	9	19	274
50%-60%	57	108	61	2	0	6	5	30	269
60%-70%	52	89	21	3	0	0	4	10	179
70%-80%	38	10	2	0	0	0	2	2	54
80%-90%	7	10	4	0	0	0	1	0	22
90%-100%	1	1	0	0	0	0	1	0	3
Post-Planned CA00	1	0	0	0	0	0	0	0	1

Table B10. CVN PIA 2 Red Color-Coded Data

Work Stoppage Reason

Percentage of Planned Duration	MAT	IC	TD	TL	SAF	W	WC	RSC	Total WS
Prior to SA00	0	0	0	0	0	0	0	0	0
0%-10%	1	3	1	0	0	0	1	0	6
10%-20%	2	3	0	0	0	0	0	0	5
20%-30%	1	5	6	0	0	0	1	0	13
30%-40%	3	7	2	1	0	0	0	0	13
40%-50%	6	33	5	0	0	3	2	0	49
50%-60%	7	25	12	0	0	1	3	3	51
60%-70%	16	25	9	1	0	0	2	4	57
70%-80%	7	3	1	0	0	0	2	0	13
80%-90%	2	6	0	0	0	0	1	0	9
90%-100%	4	1	2	0	0	0	2	0	9
Post-Planned CA00	1	0	0	0	0	0	0	0	1

Table B11. SSN CM 1 Complete Data

Work Stoppage Reason

Percentage of Planned Duration	MAT	IC	TD	TL	SAF	W	WC	RSC	Total
Prior to SA00	0	0	0	0	0	0	0	0	0
0%-10%	0	0	0	0	0	0	0	0	0
10%-20%	0	0	0	0	0	0	0	0	0
20%-30%	0	0	0	0	0	0	0	0	0
30%-40%	9	12	9	0	0	1	0	0	31
40%-50%	5	13	7	0	0	2	0	0	27
50%-60%	11	8	3	0	0	1	1	0	24
60%-70%	3	9	3	0	0	0	0	0	15
70%-80%	0	5	1	0	0	0	1	1	8
80%-90%	4	3	2	0	0	2	0	1	12
90%-100%	0	0	0	0	0	0	0	0	0
Post-Planned CA00	0	0	0	0	0	0	0	0	0

Table B12. SSN CM 1 Red Color-Coded Data

Work Stoppage Reason

Percentage of Planned Duration	MAT	IC	TD	TL	SAF	W	WC	RSC	Total WS
Prior to SA00	0	0	0	0	0	0	0	0	0
0%-10%	0	0	0	0	0	0	0	0	0
10%-20%	0	0	0	0	0	0	0	0	0
20%-30%	0	0	0	0	0	0	0	0	0
30%-40%	3	5	5	0	0	0	0	0	13
40%-50%	0	6	3	0	0	0	0	0	9
50%-60%	6	6	1	0	0	1	1	0	15
60%-70%	1	8	3	0	0	0	0	0	12
70%-80%	0	3	0	0	0	0	1	1	5
80%-90%	3	2	2	0	0	2	0	1	10
90%-100%	0	0	0	0	0	0	0	0	0
Post-Planned CA00	0	0	0	0	0	0	0	0	0

Table B13. Complete Data Pre-Availability Work Stoppage Ratio

Point in Time of Availability	CVN PIA 1 (58 Days Late)	CVN SRA 1 (26 Days Late)	SSN DSRA 1 (19 Days Late)	SSGN MMP 1 (14 Days Late)	CVN PIA 2 (1 Days Late)	SSN CM 1 (5 Days Early)
10%	66.03%	60.66%	30.86%	93.80%	28.68%	0.00%
20%	50.14%	38.76%	22.33%	35.44%	12.49%	0.00%
30%	37.16%	20.22%	14.30%	28.47%	7.86%	0.00%
40%	28.15%	16.41%	12.95%	13.99%	5.22%	0.00%
50%	23.63%	12.98%	11.31%	9.78%	3.57%	0.00%
60%	20.14%	11.34%	11.00%	7.59%	2.73%	0.00%
70%	16.41%	11.30%	9.92%	6.54%	2.36%	0.00%
80%	15.10%	10.65%	9.75%	5.88%	2.26%	0.00%
90%	13.85%	10.49%	9.48%	5.82%	2.23%	0.00%
100%	13.56%	10.18%	9.04%	5.56%	2.22%	0.00%
Post-Planned CA00	12.91%	9.52%	8.79%	5.42%	2.22%	0.00%

Table B13. Red Color-Coded Data Pre-Availability Work Stoppage Ratio

Point in Time of Availability	CVN PIA 1 (58 Days Late)	CVN SRA 1 (26 Days Late)	SSN DSRA 1 (19 Days Late)	SSGN MMP 1 (14 Days Late)	CVN PIA 2 (1 Days Late)	SSN CM 1 (5 Days Early)
10%	83.95%	86.67%	37.14%	100.00%	0.00%	0.00%
20%	68.00%	65.00%	27.66%	38.10%	0.00%	0.00%
30%	54.40%	32.50%	13.98%	30.77%	0.00%	0.00%
40%	36.96%	28.26%	12.50%	15.38%	0.00%	0.00%
50%	30.77%	22.41%	9.56%	9.41%	0.00%	0.00%
60%	23.21%	17.33%	9.09%	5.93%	0.00%	0.00%
70%	17.48%	17.33%	7.43%	5.16%	0.00%	0.00%
80%	14.56%	17.11%	7.26%	4.71%	0.00%	0.00%
90%	12.30%	17.11%	7.03%	4.68%	0.00%	0.00%
100%	12.01%	17.11%	6.13%	4.32%	0.00%	0.00%
Post-Planned CA00	10.61%	14.77%	5.70%	4.17%	0.00%	0.00%