LYNDON B. JOHNSON SPACE CENTER

Safety and Mission Assurance

NC411 Risk & Reliability Analysis Branch

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The Growth of Mass and Reliability Source Database and Me

Mass and Reliability Source (MaRS) is a database which draws together information from multiple other sources and databases (MADS, VMDB, ISS PART, Bayesian PowerPoint, etc.). Information such as mass, operating hours, and failure data are compiled to create a tool for the building of probabilistic Risk Assessment (PRA) models. MaRS also has great potential for deep space mission planning. Understanding the lowest point of failure within an ORU helps to inform the efficient selection of spare parts necessary for a journey where mass and volume are at a premium and resupply is not possible.

Most of the real database building work has been completed by previous interns. The main bulk of the work I did revolved around documenting failure data. Problem Reporting and Corrective Action (PRACA) and In Flight Investigation (IFI) reports were investigated for specific failure events. These reports are listed in MaRS and can be accessed through the ISS PART database. The goal is to understand what occurred and how so that the lowest part that failed can be identified. Once identified, its part number and MaRS database location can be documented.

This process of failure point identification was really very different case to case. In the best case scenario, the problem was well understood and the PRACA report clearly stated the culprit part and its related part number. This was rare, however. Most reports are incomplete or poorly written, making the process more investigative in nature. The cause of failure may be buried in a paragraph or, in some cases, one report will refer you to another which will refer you to another which might have some useful information. At times it is also necessary to consult technical drawings of components in order to solve the puzzle or locate a part number. Each failure, once identified, was categorized as one of four types; random, induced, wear-out, or other.

While working with MaRS, my teammate and I realized that there were a great many fields left blank. We felt that if someone were to search for a specific component in MaRS, it may not be clear whether or not the missing information exists in the source databases and simply was not recorded. That may lead the inquirer to spend time searching for that information only to find that it does not, in fact, exist in the source databases for MaRS. We have seen this in the MADS database where many fields are left blank leaving a rather ambiguous report. To resolve this issue, we checked source databases for the missing information and either added anything that was missing or annotated that the information does not in fact exist. **Figure 1** illustrates the word “None” being added to show that there are no relevant failure reports for the applicable parts. These fields were previously blank.

<table>
<tr><th>PART_NAME</th><th>NUM_ISS_REPORTS</th><th>NUM_PRACA_REPORTS</th><th>FAILURE_REPORT_NUM</th></tr>
<tr><td>CYLINDER ASSY, OXYGEN, EMERGENCY PBA</td><td>0</td><td>0</td><td>None</td></tr>
<tr><td>PBA OXYGEN REDUCER ASSY, EMERGENCY</td><td>See MaRS ID 1097.1</td><td>See MaRS ID 1097.1</td><td>See MaRS ID 1097.1</td></tr>
<tr><td>QUICK DON MASK ASSY, OXYGEN, PBA, PEP</td><td>9</td><td>5</td><td>869(IFI)|1051(IFI)|2423(IFI)|2581(IFI)|16953(PRACA)|17040(PRACA)|18345(PRACA)|18638(PRACA)|18842(PRACA</td></tr>
<tr><td>EMERGENCY PBA HARNESS ASSY</td><td>See MaRS ID 1097</td><td>See MaRS ID 1097</td><td>See MaRS ID 1097</td></tr>
<tr><td>AMMONIA RESPIRATOR ASSEMBLY- SMALL</td><td>0</td><td>0</td><td>None</td></tr>
<tr><td>AMMONIA RESPIRATOR ASSEMBLY- MEDIUM</td><td>0</td><td>0</td><td>None</td></tr>
<tr><td>AMMONIA RESPIRATOR ASSEMBLY- LARGE</td><td>0</td><td>0</td><td>None</td></tr>
<tr><td>AMMONIA CARTRIDGE ASSEMBLY</td><td>0</td><td>0</td><td>None</td></tr>
<tr><td>IODINE COMPATIBLE WATER CONTAINER ASSEMBLY</td><td>4</td><td>4</td><td>19889(PRACA)|20007(PRACA)|20069(PRACA)|20070(PRACA)</td></tr>
<tr><td>PRE-TREATED URINE TRANSFER HOSE ASSEMBLY</td><td>0</td><td>0</td><td>None</td></tr>
<tr><td>REFH PTU (PRE-TREAT URINE) T-HOSE</td><td>0</td><td>0</td><td>None</td></tr>
<tr><td>EMERGENCY MASK</td><td>0</td><td>0</td><td>None</td></tr>
<tr><td>COLIFORM DETECTION BAG</td><td>0</td><td>0</td><td>None</td></tr>
</table>

Figure 1 A sample of the MaRS database showing the word “None” being used to remove ambiguity.

MaRS is meant to be used as a tool for PRA model development. In order for this to work, bounds must be placed on the data set. It was discovered that many of the PRACA and IFI reports listed in MaRS fell outside of those bounds that had been previously set. Many reports described events that occurred after the 1/1/2012 cutoff date. Many described failures or other issues that arose with equipment that were not currently on orbit i.e. during manufacturing and ground testing. There were also several reports filed in response to missed scheduled preventative maintenance and other events that do not constitute a failure. Each report was assessed for these issues and, if found to fall outside the bounds placed on the MaRS dataset, was removed from the database.

Andrew and I took on a side project in support of the Bureau of Safety and Environmental Enforcement. This was a fantastic bonus education regarding topics that I really hadn’t thought about before. We reviewed Applications for Permission to Drill (API’s) for deep-water oil exploration and extracted information about the depth of geological features beneath the sea floor, the structure of the proposed well, and other key information. The data was used to populate a new database that will be used to build PRA models to help estimate the risk of future drilling accidents. A set of 115 graphs was developed from data sets from previously drilled deep-water wells. **Figure 2** is an example of such a graph. The idea was to look for correlations in the data with a primary focus on what matters as far as the time it takes to complete a well. Longer drill times can result in an increased risk of severe weather exposure for the drill rig and an increased probability of an accident occurring.

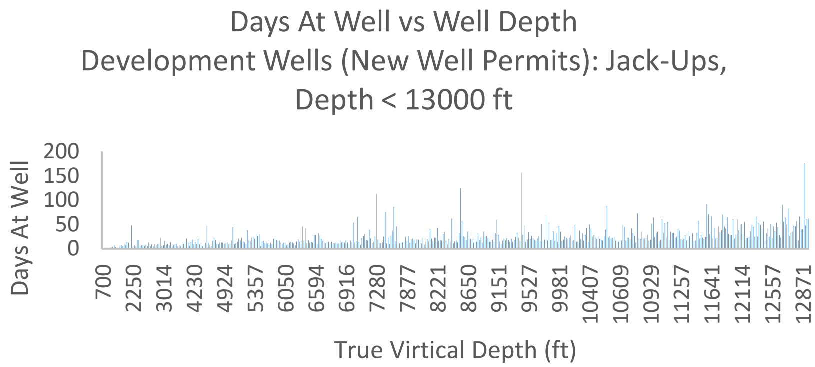

Figure 2 An example of a graph showing the time it takes to drill a well vs the depth of the well from the ocean floor.

This internship was an intense educational experience for me. I absolutely loved working with Safety and Mission Assurance. I feel like I really acquired some of that safety flavor that I can apply to anything I do in the future. For me, it was really about the wisdom to take a step back and asses what I am doing to make sure that the task is being completed in the best and safest way possible. This is an invaluable notion that will be brought with me no matter what I do. My experience at Johnson Space Center was much different from my previous tour at Stennis Space Center. JSC has a much more developed intern program with lectures happening almost twice a week. Adding in regular employee lectures and tours listed on Roundup, I was able to take advantage of an educational opportunity almost daily. I learned about space craft, deep-water oil exploration, NASA history and culture, anthropometrics and spacesuit design, small body orbital mechanics… The list goes on. These are gems that I can't wait to take with me and share with fellow students and anyone with the patience to listen to me go on about it. One of my favorite lessons this summer was taught by astronaut Victor Glover. He said to aspire to be strong… like water. Water can adapt and fit into any form it encounters, but is incompressible. You cannot compromise its volumetric integrity.