Version 1

Cost Benefit Analysis of

LH2 Pad B

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1. Introduction

This analysis is used to evaluate, from a cost and benefit perspective, potential outcomes when replacing the pressurization switches and the pressurization system to meet the needs of the LH2 storage system at Pad B. This also includes alternatives, tangible and intangible benefits, and the results of the analysis.

1.1 Purpose

The LH2 storage system at Pad B has an outdated pressurizing system (controller and valve) whose manufacturer is no longer in business. This system does not have any spare parts and was installed roughly fifty years ago. This system has had previous day-of-launch failures and has been detrimental to the entire LH2 storage facility. This analysis sheds light on the cost of replacing this system.

Similarly, the three pressure switches at the storage area can be replaced with one redundant transducer to give a more accurate reading with updated technology.

1.2 Background

There have not been any previous replacements or modifications done to the pressurizing system on Pad B, or anything similar to Pad A. However, this system has failed on multiple occasions and future failures have the possibility of causing a loss of mission.

The replacing of the three pressure switches was previously done at Pad A. The switches were replaced with a transducer from Taber Industries which has since been a beneficial component to the system.

1.3 Scope

When determining which pressurizing system would potentially replace the current system, multiple vendors were contacted to ascertain numerous options. However, there are not any complete quotes currently. One vendor gave a tentative quote which is used in this analysis but no other vendors produced quotes.

The only option considered in this analysis regarding the pressure switches is replacing them with one transducer, specifically the same model from Taber Industries that was used at Pad A. This option was previously deemed the most cost effective and beneficial therefore, there was no need seen to evaluate other possibilities.

1.4 Methodology

This analysis was done using cost estimates that may or may not have changed. The numbers used were up-to-date when the analysis was conducted and, if they have varied, should not have a large delta.

1.5 Evaluation Criteria

The criterion used to evaluate possible pressurizing systems is mostly related to cost. This is because for the system to even be considered the technical elements and specifications must be the same as the present system. Therefore, the systems considered are all capable of performing the tasks required but the main difference that is being analyzed is the total cost of purchasing and installing each.

2. Assumptions, Constraints, and Conditions

2.1 Assumptions

The assumptions of this analysis are that the costs estimated at the time of research will either remain the same or have a very small delta. This must be looked at closely before approval since total costs may change due to budget and accessibility of stocked parts. This being said, it is also assumed that all data used in this analysis are accurate, reliable and valid.

It is also assumed that the replacing of three pressure switches to one specific transducer model is the most effective and beneficial option. This can be assumed since the same project has already been approved and completed for the LH2 system at Pad A and has since improved the redundancy and pressure control along with decreased the software costs marginally.

Another assumption is regarding the pressurizing system. It is assumed that the quote included in this analysis gives a fair representation of other vendors' products and prices.

2.2 Constraints

The specifications of the replacement pressurizing system must be the same of the current system. If they were not, the proposed system would not properly maintain the storage system as the current one does.

Also, the total cost of this project must be kept at a minimum which provides for more constraints on the replacements and overall project.

2.3 Conditions

The pressurizing system that is to replace the current system must perform the same operations, at the same specifications, that the current system does. The replacement valve in the system must also function in the same manner as the previous valve.

The transducer that is to be replacing the three switches must be as effective, if not more, as the three switches. The purpose of this replacement is to gain accuracy and efficiency and therefore, the transducer must perform at these expected levels.

2.4 Recommendations

It is recommended that the same procedure and actions be taken as previously done at Pad A since this modification has been beneficial to the system.

It is also recommended that more quotes be obtained before committing the replacement of the pressurizing system. It is recommended that this replacement occur however, the costs shown in this analysis are meant as examples since not enough information is present for a complete cost benefit analysis.

3. Description of Alternatives

3.1 Current System

The current pressurizing system, A3305, controls and regulates the flow of nitrogen into the top of the LH2 tank. The system controller regulates the pressure valve, A3304, controlling the flow of the system. The assumed and estimated flow rate of this system is approximately 2 pounds per second. The current system regulates 100 psi of the nitrogen flow down to 20 psi to then travel through the system to the valve which regulates the quantity of nitrogen that passes through. This pneumatic system is explosion proof and was created to operate in a hydrogen atmosphere.

At the LH2 storage facility, there are currently three switches, A3324, A3325, and A3326, monitoring the pressure within the system. These switches affect the actions of the controller and, consequently, the valve as well.

3.2 Proposed System

A potential replacement for the pressurizing system controller is a three-piece, custom controller from the vendor. This would consist of a controller to be mounted in an enclosure and whose input would be from an additional transmitter. The suggested controller allows for easy readings and ample information. This vendor, nor any other contacted, gave a quote for the valve therefore, there is no proposed replacement.

It is proposed that a transducer, similar to A3315, replace the current switches. This transducer would be more reliable that the current switches since it would have newer technology and would give one reading versus three readings. It would allow for increased redundancy on the pressure transducer which is a much better measurement for storage tank pressure control. If implemented now, this modification would reduce software cost marginally.

3.3 Alternative System Name

There are no alternatives being considered regarding the pressurizing system since only one vendor provided a quote.

There are no alternate systems being considered when replacing the three pressure switches. This is because the same replacement was previously done at Pad A. This replacement will be exactly duplicated for the replacement at Pad B.

4. Cost Analysis

4.1 Development Costs

Table 2: Pressurizing System

Phase	Year #1	Year #2	Year #3	Amount
Development Phase	1,519.00	-	-	$1,519.00
Implementation Phase	NA	NA	NA	$NA
Total				$1,519.00

Table 1: Transducer

Phase	Year #1	Year #2	Year #3	Amount
Development Phase	14,918.29	-	-	$14,918.29
Implementation Phase	-	254,353.97	-	$254,353.97
Total				$269,272.26

4.2 Non-Recurring Costs

Purchasing costs and installation costs are non-recurring. These are the only costs seen in the above tables as there should be no operational changes, if there are changes the overall operational costs should decrease after the proposed replacements.

4.2.1 Capital Investment Costs

There are no capital investments needed for this proposed revision.

4.3 Recurring Costs

There are no recurring costs regarding the proposed renovations. The replacing of the three switches with one redundant transducer will lower the software costs of the LH2 system.

4.4 Project Cost Analysis

	Proposed
Year one	
Nonrecurring costs	$16,437.29
Recurring costs	$ -
Year Two	
Nonrecurring costs	$254,353.97
Recurring Costs	$ -
Year Three	
Nonrecurring costs	$ -
Recurring costs	$ -
Total Costs	$270,791.26*

*Not adjusted for inflation.

5. Benefit Analysis

5.1 Key Benefits

By replacing the pressurizing system, the risk of loss of mission due to a failure in the LH2 system is greatly reduced. This also allows for a more accurate reading of the pressure which, again, reduces the risk of loss of mission.

The replacing of three switches allows for increased redundancy on the pressure transducer and is a more accurate measurement for storage tank pressure control. These benefits regarding the transducer can be seen at Pad A.

5.2 Tangible Benefits

Besides the cost of the loss of mission, the cost of replacements within the LH2 system due to the failure of the pressurizing system would be a very costly replacement. By replacing this system these hefty costs are avoided.

By replacing the switches with one redundant transducer, the software cost would be reduced marginally.

5.3 Intangible Benefits

The risk of the loss of mission would be greatly reduced with both of the proposed replacements along with much more accurate measurements within the LH2 system.

6. Cost and Benefit Comparison

6.1 Cost

The immediate cost of the proposed replacements totals $584,713.00* with inflation and $296,199.00* without.

*These costs are not all-inclusive; the cost of the manufacturing of the pressurizing controller by the vendor is not included, the installation of the controller is not included along with the cost and installation of the accompanying valve for the pressurizing system.

6.1 Benefit

Besides the transducer reducing the software cost, the benefits of these replacements are not measured monetarily.

The replacements reduce the risk of loss of mission and improve the accuracy of measurements taken within the LH2 system.

7. Conclusion

This analysis cannot conclude, based on lack of data, that the upgrading of the pressurizing system is beneficial when using this vendor. It is suggested, based on this analysis, that the upgrade occur however, more quotes and estimates of installation must be obtained before an accurate conclusion can be made.

The transition from three switches to one redundant transducer is beneficial and is suggested to occur for Pad B. This conclusion is based on the results of this replacement at Pad A however, it is suggested that the cost of the transition be compared to the savings regarding the software costs at Pad A.

8. Personal Final Report

I am currently attending the University of South Florida and majoring in Industrial Engineering. Growing up on the Space Coast NASA has been an inspiration throughout my life. I have enjoyed watching rocket launches from my backyard and attending shuttle launches at KSC. Being inspired by NASA and those who work for this organization has driven me to study engineering and to have the goal of ultimately working at NASA. When the opportunity arose for an internship I was eager to begin work. I began by working on the cost benefit analysis for changes proposing to be made at the LH2 storage system at Pad B and then expanded my work. I have assisted with the Rocket University Neo Project, which is working to create a test for the first Morpheus rocket engine. I then began helping to write the procedure for a Qualifications Test for a Shut-off Ball Valve. I am now working on the merging of multiple large laboratories within KSC. One of the labs must relocate and I am working to create a plan as to where they will be relocated to, what equipment is absolutely necessary, what equipment can be excessed or put into storage, what is the cost of this relocation, and what affect will it have on the laboratories that they are moving into. These projects and the lessons learned from them will help me prepare for my future. This summer has taught me that there are many different ways to apply engineering and that in order to succeed, all of your efforts and talent must be used at all times. By seeing "inside" of NASA, I have changed how I see different careers and am more determined to work for this agency.