Cost Effective Analysis of a Damaged Manufacturing Equipment

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Abstract *— A fire in a production line of a chemical plant in Guymon, Oklahoma, caused damaged to a manufacturing pressure vessel. A cost analysis was performed to determine if the pressure vessel needed to be repaired or replaced. A full evaluation of the damaged equipment was completed. A project budget was developed and presented to management for approval. Quotes and estimates for both, repair and replacement were requested for the completion of the cost analysis. The cost analysis was completed and determined that a full replacement was the best option as it will allow the team to meet the project objectives.*

Key Terms *— budget, cost analysis, pressure vessel, repair/replacement*

INTRODUCTION

On November 2020, a fire at a manufacturing line of a chemical plant in Guymon, Oklahoma, caused damages to a critical process equipment (pressure vessel). An evaluation of the process continuity was performed to determine the need of repairing or replacing the damaged equipment.

The goal was to avoid the potential loss of gross earnings and profits and in-process materials. The focus and three main objectives of the capital project were as follows:

- Reduce the investment cost by analyzing the cost associated with repair or replacement of the damaged equipment.
- Reduce and mitigate the business interruption loss.
- Increase manufacturing line productivity.

A full evaluation of the outside and inner parts of the equipment was completed to determine the reasonable and necessary scope of work and extent of damages. The team requested various estimates and quotes to determine the most reasonable and cost-effective decision.

PROJECT STRATEGY

The first step was definition of the project objectives, second, a planning meeting was performed. During the planning meeting it was determined that the project needed to be divided by phases. First phase included the equipment clean-up, a budget preparation and budget proposal. Second phase included the cost and data analysis.

Planning

Figure 1 shows the project milestone that was prepared during the planning stage of the project. The project was presented to management during November 2020 and was expected to be completed by the end of January.

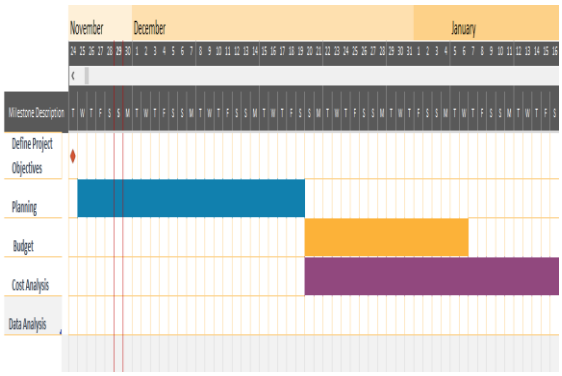

Figure 1
Project Milestone

Pressure Vessel Design

Information about the pressure vessel design was obtained. "Generally the pressure vessels are designed to store reactive fluids and sustain chemical reactions that may occur in the vessel" [1]. The thickness, material, fitting, and connections needs to be designed and evaluated before a design is started. The analytical

calculations and equipment validation are done thru a software.

While working on the design of a pressure vessel there are multiple factors and parameters needed. In typical industries, all these parameters are established by design engineers in conjunction with the chemical process experts. A pilot phase is part of the equipment design process to assure the effectiveness of the chemical process once it goes live. These aspects are considered by the designer and manufacturer of the equipment and not necessarily by the buyer.

ANALYSIS APPROACH

The cost analysis evaluation took into consideration both Property Damage to the equipment and the potential loss of business or interruption of business while the manufacturing line was down. A detailed analysis about the impact on the business and the process continuity was performed.

Budget Preparation

To track the repair/replacement costs and keep those cost within reason, a budget was requested. Some of the items that were took into consideration in the budget were: property (equipment), installation fees, validation, training, software development, approvals, etc. The budget was based on an analysis of previous experiences with the pressure vessels at this facility. Table 1 shows the submitted and approved budget.

Table 1
Approved Budget

Item	Amount (USD)
Repair/Replacement Equipment	$2,500,000
Equipment validation	$100,000
Installation cost	$150,000
Training	$10,000
External Approvals	$1,000
Software	$50,000
Miscellaneous	$25,000
Total Budget Approved	$2,836,000

Repair vs. Replacement

A third-party company evaluated the damaged equipment and provided a full report of the findings. The report included and evaluation of the extent of damage and the necessary scope of work. Estimates were request based on the mentioned report and taking in consideration the recommended repairs. In addition, a quote was requested for a full replacement so that both quotes could have been evaluated and analyzed.

Table 2 shows a comparison between cost repair vs. replacement option. The comparison is only based on property damage costs and it does not consider any additional cost or impact to the entire process as for example repair vs replacement timeliness. Therefore, a complete analysis of business process continuity was performed to understand the best option for both property damage repair costs but also avoiding the plant downtime or interruption of business.

Table 2
Repair vs. Replacement Comparison

Item	Repair (USD)	Replacement (USD)
Equipment (Pressure Vessel)	$2,100,000	$2,600,000
Equipment validation	Internal labor	$73,000
Installation cost	$100,000	$25,000
Training	N/A	$10,000
External Approvals	N/A	$1000
Software	N/A	$35,000
Miscellaneous	N/A	N/A
Total Estimate	$2.2M	$2.7M

Process Continuity

To mitigate the impact of business interruption additional steps were undertaken to explore the possibility of continuing producing using temporary equipment. Rental of temporary equipment including a temporary pressure vessel and pipelines were considered. A rough calculation of production

amounts was done and determined to be non-cost effective. Makeup facilities were also evaluated, extremely high costs in logistics to transport raw material and distribution of the product were determined to be unreasonable and therefore was not an option at the time.

Business interruption was mitigated by using the storage material. Emergency storage is being in use while the repairs are completed. Manufacturing team is currently working to determine the need of extra shifts once the line is back in running to makeup the storage product. In the meantime, amounts of products in the storage facility will allow up to four months of interruption of business without having an impact in the profits and/or earnings.

RESULTS AND DISCUSSION

Two quotes for repair and one quote for full replacement of the pressure vessel were requested. Repair of the equipment was in the range of $2.1M to $2.3M. The full replacement of the equipment was $2.6M.

Although it is noted that the repair of the equipment was less expensive than the full replacement, based on the received information, repairs to the equipment could take up to twelve weeks due to some pieces that needed replacement. However, the lead time to get a new equipment could take up to six weeks, with an expedited option the equipment could be at the facility within up to four weeks. As previously outlined, one of the key items is to mitigate and avoid the business interruption loss. Therefore, the cost analysis suggests that even when repair option appears to be cheaper, at the end of the day a bigger loss can be avoided by having the equipment on site within four weeks. This will allow the manufacturing line to start running within the next eight weeks and will ensure to maintain enough product in the market.

A new equipment would allow to produce more product per minute since it is a new technology. Therefore, although it represents more capital at the beginning, in the upcoming years will represent a reduction in cost and an incremental in the production line.

CONCLUSION

Buying a full replacement of the pressure vessel is going to be within budget and will also meet all the project objectives. The decision that makes more sense based on timeliness and mitigation of a further loss is to replace the vessel. In addition, some of the costs associated with the new equipment will be recovered once the old equipment is sold as salvage. Some of the next task include employees training for the new equipment and installation. Currently, it is estimated that installation will take up to two weeks.

The project is still on-going, however, cost effective analysis stage and final decision were completed during the first week of February. Project has met the expectations and the established milestone.

REFERENCES

[1] Johnson, T. “Drivers for Cost-Effective Pressure Vessel Manufacturing,” Available: https://info.thinkcei.com/think-tank/pressure-vessel-manufacturing