Quality Control and Testing of Vapor Isolation Methodology
Overview
The team was given a provided pipe diameter and was tasked with constructing a testing apparatus to validate the integrity of a mud plug vapor seal across a four to twenty-four hour time frame. The team needed to verify vapor seals using mix ratios provided by the company. Additionally, the pipe was exposed to vibration and heat following mud plug installation to simulate movement and heat associated with the fit-up and welding of pipe, respectively. The team needed to develop and validate a quality control testing method and guidelines, such as hardness testing, to verify conformance to the provided company mud plug mixing procedure.

Objectives
The goal of this project was to develop a standardized procedure for testing the validity of bentonite mud in low-pressure vapor sealing applications in steel pipes that are less than 36 inches in diameter. For each run of the experiment, multiple parameters were varied and measured in order to determine the optimal parameters. These parameters include: the weight mixture ratio of bentonite to water, the hardness of each mudball, the internal pipe pressure, the temperature of the pipe and the frequency of the vibration source. Overall, the objective of Team Mud Plug was to obtain vital experimental data through an optimal experimental design.

Approach
● Customer needs were obtained from Marathon Petroleum Corporation via an in-person meeting, as well as email communication, and they were weighed using an analytic hierarchy matrix to determine the importance of each criterion.
● MPC provided a report of quality assurance procedures for mud plugs done by a consulting company to supply relevant information on previous testing.
● Team Mud Plug generated eight concepts to test the integrity of the mud plug based on findings from patent and external research.
● Pugh Concept scoring and screening was utilized for selection of concepts for the testing apparatus; heating tape was selected as the heat source and a DC motor with an off-centered weight was selected for the vibration source.
● CAD models were created in SolidWorks of several parts of the setup. The pipe, the pipe stands, ratchet straps, 12V DC motor with attached weight and set screw, and motor cap were modeled.
● Multiple prototypes were created. The main difference between the prototypes was the tool chosen to detect internal pipe pressure. Our first prototype utilized an analog pressure gauge, but since it was not sensitive enough to detect low pressures, we switched to a much more sensitive digital differential manometer.
● Several tests were performed using our experimental setup. Team members created and installed the mud plug.
● The airtight integrity of the setup was the most important parameter that showed that the mud plug or injection piping was not leaking any air. To validate that there were no air leaks, Windex was periodically sprayed onto the plug and injection piping to see if there was any presence of bubbles. No bubbles meant that there were no leaks.
● Results were derived from gathered empirical data and visual inspection. Over the period of four to five hours, measurements of heating tape temperature, pipe temperature, and internal pipe pressure were recorded and then plotted into a graph. However, based on the time constraints of the project, only four successful tests were performed, and only two yielded recordable data. Two sets of data is not enough to determine a feasible conclusion.

Outcomes
As a result of this project, MPC will now have a standardized procedure based on our testing setup to continue testing the integrity of bentonite mud plugs as a replacement for mechanical plugs.