



System FINAL PROTOTYPE

Subsystem N/A

Component N/A

Design Lead N/A

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**Potential
Failure Mode and Effects Analysis
(Design FMEA)**

Key Date 3/2/2019

FMEA Number 1

Prepared By JAKOB HEMPHILL

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| Component | Item / Function | Potential Failure Mode(s) | Potential Effect(s) of Failure | S e v | Potential Cause(s)/ Mechanism(s) of Failure | P r o b | Current Design Controls | D e t | R P N | Recommended Action(s) | Responsibility & Target Completion Date | Action Results | | | | |
|------------------|--|--|---|-------------|---|------------------|---|-------------|-------------|--------------------------|---|----------------|---------|---------|---------|---------|
| | | | | | | | | | | | | Actions Taken | New Sev | New Occ | New Det | New RPN |
| In-Line Heater | Heat the air as it passes through | unintentional ground to pipe or surroundings | loss of power to the system | 6 | excess heat to the wire could potentially cause sagging | 2 | regulate heat and fluid flow to keep wires within safe temperature range | 3 | 36 | | | | | | | |
| In-Line Heater | Heat the air as it passes through | unintentional ground to pipe or surroundings | possible arching, to the pipe wall | 7 | excess heat to the wire could potentially cause sagging | 1 | regulate heat and fluid flow to keep wires within safe temperature range | 1 | 7 | | | | | | | |
| In-Line Heater | Heat the air as it passes through | Broken connections within device | loss of power to the system | 5 | poor manufacturing or external misuse (dropping, bumping etc) | 2 | care must be taken when moving components | 3 | 30 | | | | | | | |
| In-Line Heater | Heat the air as it passes through | broken connections with power supply | loss of power to the system | 5 | poor manufacturing or external misuse (dropping, bumping etc) | 3 | care must be taken when moving components | 3 | 45 | | | | | | | |
| In-Line Heater | Heat the air as it passes through | broken connections with power supply | loss of power to the system | 5 | poor solder or attachment to the power supply | 3 | double check connections both visually and with voltmeter | 2 | 30 | | | | | | | |
| chamber assembly | contains the gravel that makes up the testing beds | breaking of the supports while loading | reduced strength and load supporting of that member | 7 | miscalculated support strength. | 3 | calculations were thoroughly done and looked over by both team members | 1 | 21 | | | | | | | |
| chamber assembly | contains the gravel that makes up the testing beds | breaking of the supports while loading | reduced strength and load supporting of that member | 7 | poor support assembly | 3 | assembly was completed to high standards and checked by both team members | 1 | 21 | | | | | | | |
| chamber assembly | contains the gravel that makes up the testing beds | cracking of the wall or floor | reduced strength and load supporting of that wall section | 6 | miscalculated wall strength. | 3 | calculations were thoroughly done and looked over by both team members | 2 | 36 | | | | | | | |

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| | | | | | | | | | | | | Actions Taken | New Sev | New Occ | New Det | New RPN |
| chamber assembly | contains the gravel that makes up the tesitng beds | cracking of the wall or floor | reduced strength and load supporting of that wall section | 6 | mismatched seams of materials could lead to inadiquite support at a seam | 3 | assembly was completed to high standards and checked by both team members | 2 | 36 | | | | | | | |
| chamber assembly | contains the gravel that makes up the tesitng beds | cracking of the wall or floor | minor leakage of gravel | 6 | mismatched seams of materials could lead to easier cracking or spilling | 3 | assembly was completed to high standards and checked by both team members | 2 | 36 | | | | | | | |
| chamber assembly | contains the gravel that makes up the tesitng beds | breaking of the wall or floor | major leakage of gravel | 8 | miscalculated wall strength. | 3 | extra support structure can be attached to wall if evidence of breaking occurs | 1 | 24 | | | | | | | |
| chamber assembly | contains the gravel that makes up the tesitng beds | plywood walls catch fire | catastrophic failure | 9 | excess heat passed into the chamber could possibly ignite the plywood | 1 | cement board insulation is attached to the plywood and an insulating gravel layer exists between the cement board and testing beds | 1 | 9 | | | | | | | |
| air blower | supplies the air flow to the testing chamber | loss of power to the fan | air does not flow through the system | 5 | the system does not flow air through the chamber | 2 | strong connections to the motor | 2 | 20 | | | | | | | |
| air blower | supplies the air flow to the testing chamber | loss of power to the fan | air does not flow through the system | 5 | the air heater creates dangerous air temperatures | 1 | visual supervision will turn off the heater should the blower turn off | 1 | 5 | | | | | | | |
| air blower | supplies the air flow to the testing chamber | fan blade jam | air does not flow through the system | 5 | the system does not flow air through the chamber | 2 | a guard can be placed in front of the fan opening to protect from foreign objects | 2 | 20 | | | | | | | |
| air blower | supplies the air flow to the testing chamber | fan blade jam | air does not flow through the system | 7 | the air heater creates dangerous air temperatures | 1 | visual supervision will turn off the heater should the blower turn off | 1 | 7 | | | | | | | |
| air blower | supplies the air flow to the testing chamber | fan blade jam | the motor attempts to run against the jam | 7 | the motor burns out or breaks | 2 | a guard can be placed in front of the fan opening to protect from foreign objects | 2 | 28 | | | | | | | |
| air blower | supplies the air flow to the testing chamber | fan blade jam | damage is caused to the fan blades or housing | 6 | unbalanced fan blades could damage the housing, motor, or environment | 3 | visual inspection of all components will be done before operation | 2 | 36 | | | | | | | |
| air blower | supplies the air flow to the testing chamber | fan blade jam | damage is caused to the fan blades or housing | 6 | hole in the housing causes loss of pressure supply | 3 | visual inspection of all components will be done before operation | 1 | 18 | | | | | | | |
| air blower | supplies the air flow to the testing chamber | excess pressure creates excess strain on motor | the motor attempts to run against the pressure | 7 | the motor burns out or breaks | 5 | visual supervision will turn off the blower should excess pressure conditions appear | 3 | 105 | | | | | | | |

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|------------------------|---|---|---|-------------|--|------------------|---|-------------|-------------|-----------------------|---|----------------|---------|---------|---------|---------|
| | | | | | | | | | | | | Actions Taken | New Sev | New Occ | New Det | New RPN |
| data collection system | collect temperature data at staged points within the chamber, and within the pipe before and after the chamber. | cut thermocouple wire | no data is collected from that section | 4 | sharp rocks cut through the thermocouple wire | 5 | thermocouples will be delivered into the chamber via PVC pipe | 4 | 80 | | | | | | | |
| data collection system | collect temperature data at staged points within the chamber, and within the pipe before and after the chamber. | thermocouple junction breaks | no data is collected from that section | 4 | sharp rocks or tension in the wire breaks the junction | 5 | thermocouple ends will be exposed, unavoidable if occurs | 4 | 80 | | | | | | | |
| data collection system | collect temperature data at staged points within the chamber, and within the pipe before and after the chamber. | op amp burns out | no data is collected from that section | 4 | excess voltage or poor soldering causes a short. | 5 | soldering will be visually inspected and redone if necessary | 2 | 40 | | | | | | | |
| data collection system | collect temperature data at staged points within the chamber, and within the pipe before and after the chamber. | bad connection between op amp and circuit | bad data or no data is collected from the section | 5 | poor soldering causes a short or non-connection between the op amp and circuit | 5 | soldering will be visually inspected and redone if necessary | 3 | 75 | | | | | | | |
| data collection system | collect temperature data at staged points within the chamber, and within the pipe before and after the chamber. | loss of power to the arduino | no data is collected from that section | 4 | power failure from the USB cable. | 2 | USB and PC power will be checked before data collection | 1 | 8 | | | | | | | |