Test Plan

Section 1- Introduction:
This document outlines the plan to test and verify compliance to engineering specifications for Dresser Rand’s Olean Plant VECTRA power turbine assembly room expansion. The Engineering specifications were established in September 2009 and were the basis for design and construction. These specifications will be used to verify and validate the feasibility of all work completed. Engineering specifications can be found in Appendix A of this document.

When the room is complete, compare all the data gathered before the room changes were implemented to the data gathered after the room change to see the effectiveness of the new layout at that particular time. The efficiency of the room will be obvious and will continue to increase the more the workers work in the room.

<table>
<thead>
<tr>
<th>Metric #</th>
<th>Metric</th>
<th>Importance</th>
<th>Units</th>
<th>Before</th>
<th>After</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Recordable Injuries</td>
<td>1</td>
<td>Injuries/Month</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>2</td>
<td>Near Miss Incidents</td>
<td>1</td>
<td>Near Misses/Month</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>3</td>
<td>VECTRA Production Time</td>
<td>1</td>
<td>Weeks/unit</td>
<td>≤4</td>
<td>4</td>
</tr>
<tr>
<td>4</td>
<td>Economic Payback</td>
<td>2</td>
<td>Years</td>
<td>≤6</td>
<td>1</td>
</tr>
<tr>
<td>5</td>
<td>Unit Setup Time Delay</td>
<td>2</td>
<td>Days</td>
<td>≤5</td>
<td>3</td>
</tr>
<tr>
<td>6</td>
<td>Non-Ergonomic Movements</td>
<td>2</td>
<td>Movements/Day</td>
<td>TBD</td>
<td>Out of Scope</td>
</tr>
<tr>
<td>7</td>
<td>Usable Work Surface</td>
<td>2</td>
<td>Square Feet</td>
<td>≥90 Sq ft</td>
<td>95 Sq ft</td>
</tr>
</tbody>
</table>

Section 2- Recordable/ Near Miss Incidents:
Due to the similarity of these two specifications, one test plan will be sufficient to test both recordable and near miss injuries. VECTRA safety form (Appendix B) should be filled up by the VECTRA area manager on a quarterly basis. This form would allow management to verify that safety standards established as part of the expansion process meet or exceed the requirements mention in engineering specs. A recordable injury is an injury that would result in medical treatment beyond first aid, days away from work, restricted work, and loss of consciousness or death (OSHA.com). A near miss is where a recordable injury could have occurred but did not. By preventing near misses, recordable injuries will not occur in the future. This would ensure a safer work environment and potential expenses in workers compensation claims. Presently there are no recordable injuries or near miss incidents in the VECTRA room. One of the goals of the project is to maintain this. The metric for measuring this spec in injuries per quarter in the VECTRA room and the ideal value of this metric would be 0.

Section 3- VECTRA Production Time and Unit Setup Time Delay:
Due to the similarity of these two specifications, one test plan will be sufficient to test both production time and unit setup time delay. The production cycle of 30G and 40G VECTRA power turbines is ≤4 weeks per unit. The entire cycle can occur within the time frame of 4 weeks if there
are no setup delays, parts missing, defective part repairs, supplier delays, testing delays or other related delays. The ideal value for the metric is 3 weeks per unit. It is critical that the production time is minimal since DR has meet project competition and delivery dates for each of their customers.

The current process of building a VECTRA turbine includes more than 5 days of unit setup delay time. The ideal value of delays due to the above mentioned reasons need to be no more than 2 days per cycle. The form in Appendix C would help analyze if design changes in the VECTRA room expansion helped in reducing the delay and meet the engineering specification. The form in Appendix C would help the area manager to analyze why there were production delays and help avoid them for future build cycles. The final portion of the form asks the area manager to list down the possible causes for delay. The following things are some of the indictors of delay in production time -Part unavailability, missing tools/equipment, poor material flow and operator efficiency.

Section 4- Economic Payback:
Many of our decisions were influenced by capital. Every proposal that we present to D-R must be able to pay itself off in a reasonable amount of time. Most of these proposals will quickly pay themselves off with an increased production rate. Examples of such include new cranes, build stands, tooling, work surfaces, and expanded clean room space. These paybacks will not be analyzed because they will require data acquisition and analysis after the project is complete, which there is insufficient time for. However, the removal and replacement of the oven is one economic analysis that we could speculate. There will not be a true test of this payback. To get a true payback, energy consumption of the existing oven and new oven would have to be analyzed. Just as before, there is insufficient time to accomplish this. However, assumptions and speculations can be used to examine the payback before the oven is installed. Using benchmarking to compare the old oven to a newer one of similar technology, the energy consumption is approximated. The new oven has published energy consumption data. Putting these together can give an economic payback, as shown on the EDGE project website.

Section 5- Non-Ergonomic Movement:
There were a few non-ergonomic movements that were identified during the VECTRA room analysis. All of them occur at different phases of the VECTRA build process. Since it is not possible to observe all the ergonomic movements throughout the build cycle of one unit, it is difficult to measure the number of non-ergonomic movements/day. A checklist of these movements that an operator can use to record the type of non-ergonomic movements he had to perform that day, may give us an Idea of how much period of time or how many times these occurred. This can be carried out for a week before the design changes occur and a week after the construction and inclusion of the solutions suggested for non-ergonomic movements are incorporated in the room. This will help the team verify if the changes to the design of the room and the proposed ergonomic solutions did in fact help improve the work conditions of the operators. The marginal value of non ergonomic movements per day is currently unknown, but the ideal value in this situation needs to be close to zero.

Section 6- Usable Work Surface:
The current total work surface is 40ft² and there is a requirement for 25% additional surface for the operators and engineers to work in the VECTRA room. The second build stand requires double the capacity of work surface; hence the new design needs to consider a 250% increase in usable work surface area. The Ideal value for this metric would be 100 ft². The detail design for the expansion of
the VECTRA room includes a counter top (31 ft²), Work Surface with under-Cart Storage (21 ft²) and Work Surface at the back wall (43 ft²). New Total Work Surface Area according to the detail design of the expanded VECTRA assembly room is 95 ft². This is close to the Ideal value of the engineering spec. There may be requirement in the future for more work surface area due to unforeseen reasons. The followings question can be asked after the construction to validate that the increased work surface would suffice the need, for use of both the build stands simultaneously.

- Is the current work surface sufficient, too much or just enough?
- What objects occupy most amount of space on each of the work surfaces?
- Can any of those objects be kept in another location like in storage rack or wall mounted?
- How much more space would be required and for what purpose?
- Are the heights and widths of the work surfaces ideal? Would any changes make the operator’s and engineer’s job easier?