

# Project Progress Measurement – A Qualitative Approach

(A case study emphasizing the Quality Attribute as a cost saving project management tool)

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Traditional progress measurement focuses on time, budget, and resources. This paper proposes a quality-oriented approach using Production Efficiency Percentage (PEP). Replacing "General Economy" with a fixed "General Quality" (100%) in PEP prioritizes quality throughout the project. A case study on mechanical equipment installation demonstrates substantial cost savings (Total Installation Cost) and reduced project time due to fewer rework cycles when using the quality-oriented PEP. This approach has potential for broader application across project disciplines and scales.

**Keywords**—Quality-Oriented Project Management, Production Efficiency Percentage (PEP), Project Cost Savings, Schedule Optimization, Quality Attribute Integration

## I. INTRODUCTION (PROJECT PROGRESS MEASUREMENT)

Assessing the rate at which a project is progressing in terms of time and money resulting in the delivery of a successful result is commonly referred to as progress measurement of an ongoing project. As part of the project control process, it also involves monitoring related resources that have been used at any point in time having visibility over the tasks and milestones that have been completed. Putting it in simple terms, if target percent complete is greater than actual percent complete then the project is behind schedule. If target percent complete is less than actual percent complete, then the project is ahead of schedule.

## II. PRODUCTION EFFICIENCY PERCENTAGE (PEP) AND PRODUCTIVITY

A. PEP: (actual output rate / standard output rate) x 100

A business entity executing a project of any magnitude considers many factors when deciding to use their resources to progress the project. Production efficiency, which is an important production factor, refers to a point where production reaches full capacity and maximum efficiency. If the job involves production, it's important to understand the concept of production efficiency and the production efficiency. The PEP is classified into five categories based on the comparison of numerous executed past projects [1] which are mentioned below:

<b>General Economy:</b>			
Business trends and outlooks	Construction volume	The employment situation	
<b>Project Supervision:</b>			
Experience	Supply	Pay	
<b>Labor Relations:</b>			
Experience	Supply	Pay	
<b>Job Conditions:</b>			
Scope of Work	Site Conditions	Material Procurement	Manual & Mechanized Operations
<b>Equipment:</b>			
Usability	Condition	Maintenance & Repair	
<b>Weather:</b>			
Past Weather Reports	Rain or Snow	Hot or Cold	

### B. PEP @ 75% - General Economy

An average PEP percentage for a project that is executed at a stable location (country/region) can be determined as 80% based on the below:

<b>Very Low</b>	10%	to	40%
<b>Low</b>	41%	to	60%
<b>Average</b>	61%	to	80%
<b>Very Good</b>	81%	to	95%
<b>Excellent</b>	96%	to	100%

	Very Low	Low	Average	Very Good	Excellent	Total
General Economy			75%			75%
Project Supervision				85%		85%
Labor Relations				85%		85%
Job Conditions			65%			65%
Equipment				85%		85%
Weather		60%				60%
<b>PEP%</b>						<b>75%</b>

C. Composite Rate for 75% PEP

For this case study, the following crew of 13 people were assumed to carry out the Mechanical tasks. The composite rate of \$38.43 was arrived based on 120 hours bi-weekly (60 hours work week) which is the composite manhour rate for 100% of the time.

Total for 120 Hours				\$38.43
	13	32	\$160.00	\$4,612.00
<b>Mechanical Crew</b>	<b>QTY</b>	<b>Hours</b>	<b>Hourly Rate</b>	<b>Total</b>
General Foreman	1	2	\$46.00	\$92.00
Foreman	1	10	\$42.00	\$420.00
Millwright (MR)	9	10	\$38.00	\$3,420.00
MR Apprentice	2	10	\$34.00	\$680.00

The composite rate of \$38.43/hour are based on an average productivity of 75%, therefore the composite rate of \$38.43 becomes equal to 75%.

D. Re-factored PEP to 80% - From General Economy to General Quality

For each project, before the labor value is calculated, the PEP should be determined. In the conventional project management, the General Economy attribute is considered, but being a leading element, for this research paper, the General Economy is replaced by General Quality attribute rated at 100% which shall be always fixed at Excellent” as quality can never be compromised to a level below 100%.

	Very Low	Low	Average	Very Good	Excellent	Total
General Quality					100%	100%
Project Supervision				85%		85%
Labor Relations				85%		85%
Job Conditions			65%			65%
Equipment				85%		85%
Weather		60%				60%
<b>PEP%</b>						<b>80%</b>

E. Composite Rate for 80% PEP

The same crew of 13 people were tasked to carry out the Mechanical tasks with a revised PEP of 80% after replacing the General Economy attribute with General Quality.

Total for 120 Hours				\$38.43
	13	32	\$160.00	\$4,612.00
<b>Mechanical Crew</b>	<b>QTY</b>	<b>Hours</b>	<b>Hourly Rate</b>	<b>Total</b>
General Foreman	1	2	\$46.00	\$92.00
Foreman	1	10	\$42.00	\$420.00
Millwright (MR)	9	10	\$38.00	\$3,420.00
MR Apprentice	2	10	\$34.00	\$680.00

This means a gain of 5% of time paid per man hours which means the composite rate will have an adjustment of 5% (manhour rate of 100% time minus the 5% gain = 95%).

The revised composite rate now will be \$38.43 x 95% = \$36.51 for 80% Productivity Efficiency Percentage (PEP).

III. CREW RATES

Appendix – 1 displays the average Craft Rates (dollar values) that were tabulated from the data received from various Engineering Procurement Construction (EPC) organizations based on a detailed survey that was carried out for this case study.

IV. COMPOSITE RATE – APPLIED TO THIS CASE STUDY

For the purpose of this case study, 6 critical mechanical equipment installation for a project were selected. The total manhours estimated for the installation of the below categorized (6 items) Mechanical Equipment were estimated as 40190.36 (data conceived from average of historical data and from project estimate).

Manhours	Mechanical Equipment
5575.86	FAN & BLOWER(EA)
2233.7018	Material Handling Equipment/ Refrigeration Equipment/Special Equipment (Designed Tag Items Only)/ Water/Treatment/Equipment (EA)
10688.7659	Compressors & Dryers/ Exchangers (EA)
9150.7721	FIRED HEATER&BOILER (EA)
98.2829	THERMAL OXIDIZER (EA)
12442.9841	AUX BOILER (EA)
<b>40190.36</b>	<b>Total</b>

A. Application of Composite Rate for 75% PEP

The composite crew rate derived of \$38.43 based on the 75% Productivity Efficiency Percentage (PEP) that is based on the PEP attributes mentioned in the above Sections II -B&C results in the Total Installation Cost (TIC) of \$1,544,515.53.

Manhours	Crew Size	Composite Crew Rate	PEP	Time Spent	Total Installation Cost
40190.36	13	\$38.43	75%	100%	\$1,544,515.53

Now the focus is shifted to a PEP of 80% in below section “B” which is based on the PEP attributes mentioned in the section II D.

B. Application of Composite Rate for 80% PEP

Manhours	Crew Size	Composite Crew Rate	PEP	Time Spent	Total Installation Cost
40190.36	13	\$36.51	80%	95%	\$1,467,350.04

The composite crew rate was ascertained as \$36.51 based on the 80% Productivity Efficiency Percentage (PEP) which was obtained by replacing [1] the General Economy attribute with General Quality attribute. Introducing the quality attribute in fact reduced the time spent along with a reduction in the

<sup>1</sup> The reason to replace General Economy attribute with General Quality Attribute is to avoid the “double dipping” of the General Economy attribute while applying Production Efficiency Percentage (PEP) as any project is considered as a “go” only based on the General Economy being stable or viable, so that attribute is already considered during the decision-making stage. So, again considering the General Economy attribute in the PEP actually defeats the purpose of the PEP.

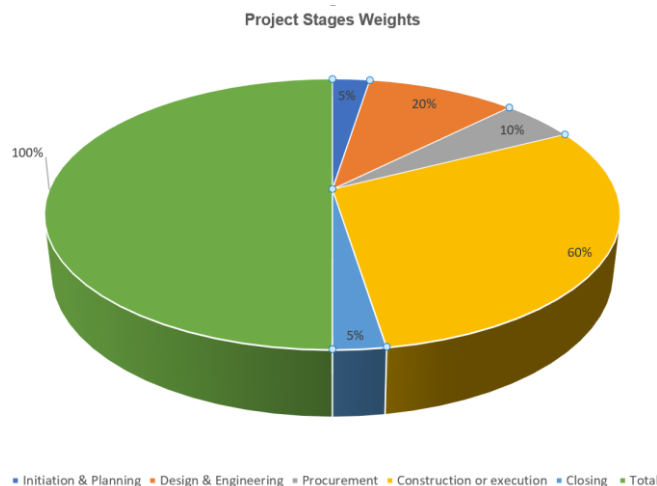
composite crew rate resulting in a reduced Total Installation Cost (TIC). The Total Installation Cost (TIC) was estimated as **\$1,467,350.04**. This difference in TIC is **\$77,165.49**. This is a cost saving.

### V. CASE STUDY – APPLIED ON A BROADER SPECTRUM

The above experimented case study can be applied to a broader spectrum, i.e. to disciplines other than Mechanical, such as Civil, Structural, Piping, Electrical & Instrumentation and Telecommunications by applying the PEP attribute(s) mentioned in the section II. Also, this case study was carried out based on analyzing the data collected by way of experimenting the Mechanical Installation (mentioned in section 4) on a petrochemical project.

A typical oil & gas/petrochemical facility construction project valued at 16 billion US\$ as the total project cost (or any project value) has the following stages in the project management cycle starting from initiation & planning to closeout of which the construction (or execution) being the heavy weight item with most of the manhours and cost associated.

Project Management - Stages	Weights	Project Cost (In Billions)
Initiation & Planning	5%	\$0.80
Design & Engineering	20%	\$3.20
Procurement	10%	\$1.60
Construction or execution	60%	\$9.60
Closing	5%	\$0.80
<b>Total</b>	<b>100%</b>	<b>\$16.00</b>



By applying the revised composite rate and revised PEP devised (by implementing the quality attribute) from the sections II, III and IV mentioned above to the construction cost of US\$9.6 billion, a total cost saving of US\$ 50.48 million is achieved, which is a substantial cost saving for a mega project of the value of US\$ 16 billion.

### VI. CONCLUSION

The experimented case study carried out with two scenarios. 1) without quality attribute implemented at every step – Appendix – 2.1 & Appendix – 2.2 and 2) with quality attribute implemented at every step –Appendix 3.1 & Appendix – 3.2 has clearly showcased that there will be a substantial cost savings with regards to Total Installation Cost (TIC) with reduced spent time.

In this case study, for the installation of the mechanical equipment noted in section 4 by spending 40190.36 manhours with two different PEP’s (%) as noted in sub-sections IVA & B has clearly shown that by implementing a quality oriented installation (of the mechanical equipment) at every step as per above noted appendices 3.1 & 3.2 against the non-quality oriented installation approach as noted in appendices 2.1 & 2.2 shows a substantial cost saving and less time being spent.

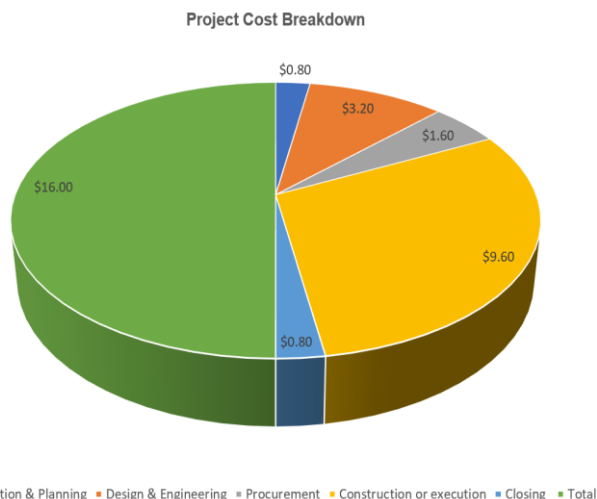
When this is implemented on a large-scale installation and to other disciplines (beyond mechanical) such as civil, structural, piping, electrical and instrumentation will result in the same cost saving and lesser schedule time spent.

### REFERENCES

[1] Page, J. S. (1999). Estimator’s piping man-hour manual. Gulf Professional Pub.

### APPENDICES

- Appendix – 1 Craft Rate Table
- Appendix – 2.1 Mechanical Equipment Installation - Rules of Credit - Without Quality Attribute - %
- Appendix – 2.2 Mechanical Equipment Installation - Rules of Credit - Without Quality Attribute - Man Hours
- Appendix – 3.1 Mechanical Equipment Installation - Rules of Credit - With Quality Attribute - %
- Appendix – 3.2 Mechanical Equipment Installation - Rules of Credit - With Quality Attribute - Man Hours



APPENDIX – 1: CRAFT RATE TABLE

Job Title	Non-Certified	Performance Verified or Written Verified	Certified+	Lead (min)	Lead (max)	FM (min)	FM (Max)	GF (Min)	GF (Max)
Boilermaker	\$ 34.00	\$ 35.00	\$ 36.00	\$ 37.00	\$ 38.00	\$ 40.00	\$ 42.00	\$ 42.00	\$ 46.00
Carpenter	\$ 32.00	\$ 33.00	\$ 34.00	\$ 35.00	\$ 36.00	\$ 38.00	\$ 40.00	\$ 40.00	\$ 44.00
Cement Finisher	\$ 32.00	\$ 33.00	\$ 34.00	\$ 35.00	\$ 36.00	\$ 38.00	\$ 40.00	\$ 40.00	\$ 44.00
Electrician	\$ 34.00	\$ 35.00	\$ 36.00	\$ 37.00	\$ 38.00	\$ 40.00	\$ 42.00	\$ 42.00	\$ 46.00
Instrument Fitter	\$ 33.00	\$ 34.00	\$ 35.00	\$ 36.00	\$ 37.00	\$ 39.00	\$ 41.00	\$ 41.00	\$ 45.00
Instrument Tech	\$ 41.00	\$ 42.00	\$ 43.00	\$ 44.00	\$ 45.00	\$ 47.00	\$ 49.00	\$ 49.00	\$ 53.00
Instrument Tech/Electrician	\$ 43.00	\$ 44.00	\$ 45.00	\$ 46.00	\$ 47.00	\$ 49.00	\$ 51.00	\$ 51.00	\$ 55.00
Insulator / Sheet Metal Mechanic	\$ 28.00	\$ 29.00	\$ 30.00	\$ 31.00	\$ 32.00	\$ 34.00	\$ 36.00	\$ 36.00	\$ 40.00
Ironworker	\$ 34.00	\$ 35.00	\$ 36.00	\$ 37.00	\$ 38.00	\$ 40.00	\$ 42.00	\$ 42.00	\$ 46.00
Millwright	\$ 34.00	\$ 35.00	\$ 36.00	\$ 37.00	\$ 38.00	\$ 40.00	\$ 42.00	\$ 42.00	\$ 46.00
Operator, Crane			\$ 41.00						
Operator, Heavy Equipment (includes Dirt)	\$ 36.00	\$ 37.00	\$ 38.00						
Operator, Light Equipment (includes Forklift)	\$ 34.00	\$ 35.00	\$ 36.00						
Painter / Sandblaster	\$ 28.00	\$ 29.00	\$ 30.00	\$ 31.00	\$ 32.00	\$ 34.00	\$ 36.00	\$ 36.00	\$ 40.00
Pipe Fitter	\$ 34.00	\$ 35.00	\$ 36.00	\$ 37.00	\$ 38.00	\$ 40.00	\$ 42.00	\$ 42.00	\$ 46.00
Rigger	\$ 34.00	\$ 35.00	\$ 36.00	\$ 37.00	\$ 38.00	\$ 40.00	\$ 42.00	\$ 42.00	\$ 46.00
Rodbuster	\$ 32.00	\$ 33.00	\$ 34.00	\$ 35.00	\$ 36.00	\$ 38.00	\$ 40.00	\$ 40.00	\$ 44.00
Scaffold Builder	\$ 28.00	\$ 29.00	\$ 30.00	\$ 31.00	\$ 32.00	\$ 34.00	\$ 36.00	\$ 36.00	\$ 40.00
Structural Fitter	\$ 34.00	\$ 35.00	\$ 36.00	\$ 37.00	\$ 38.00	\$ 40.00	\$ 42.00	\$ 42.00	\$ 46.00

APPENDIX 2.1:  
MECHANICAL EQUIPMENT INSTALLATION - RULES OF CREDIT - WITHOUT QUALITY ATTRIBUTE - %

Item A	FAN & BLOWER(EA)
Item B	Material Handling Equipment/ Refrigeration Equipment/Special Equipment (Designed Tag Items Only)/ Water/Treatment Equipment (EA)
Item C	Compressors & Dryers/ Exchangers (EA)
Item D	FIRED HEATER&BOILER (EA)
Item E	AGITATOR&MIXER (LF)
Item F	THERMAL OXIDIZER (EA)
Item G	AUX BOILER (EA)
Item H	Exchangers/ Flare/ Material Handling Equipment/ Ash Handling System/ Shop Fab Modules/Skids/ Reactors/Towers And Columns/ Water Treatment Equipment (EA)
Item I	SFMS-SKIDS (EA)
Item J	REACTOR (EA)
Item K	GAS STORAGE SYSTEM (EA)
Item L	HOT OIL HEATER PACKAGE (EA)
Item M	GENERATORS/ SPEC EQUIP-SILENCER/ VESSEL (EA)
Item N	MHE-DISCHARGE STATION (EA)
Item O	MHE-BIN ACTIVIAATOR/VIBRATOR
Item P	MHE - (EA)
Item Q	PUMP-MOTOR
Item R	FLARE (EA)

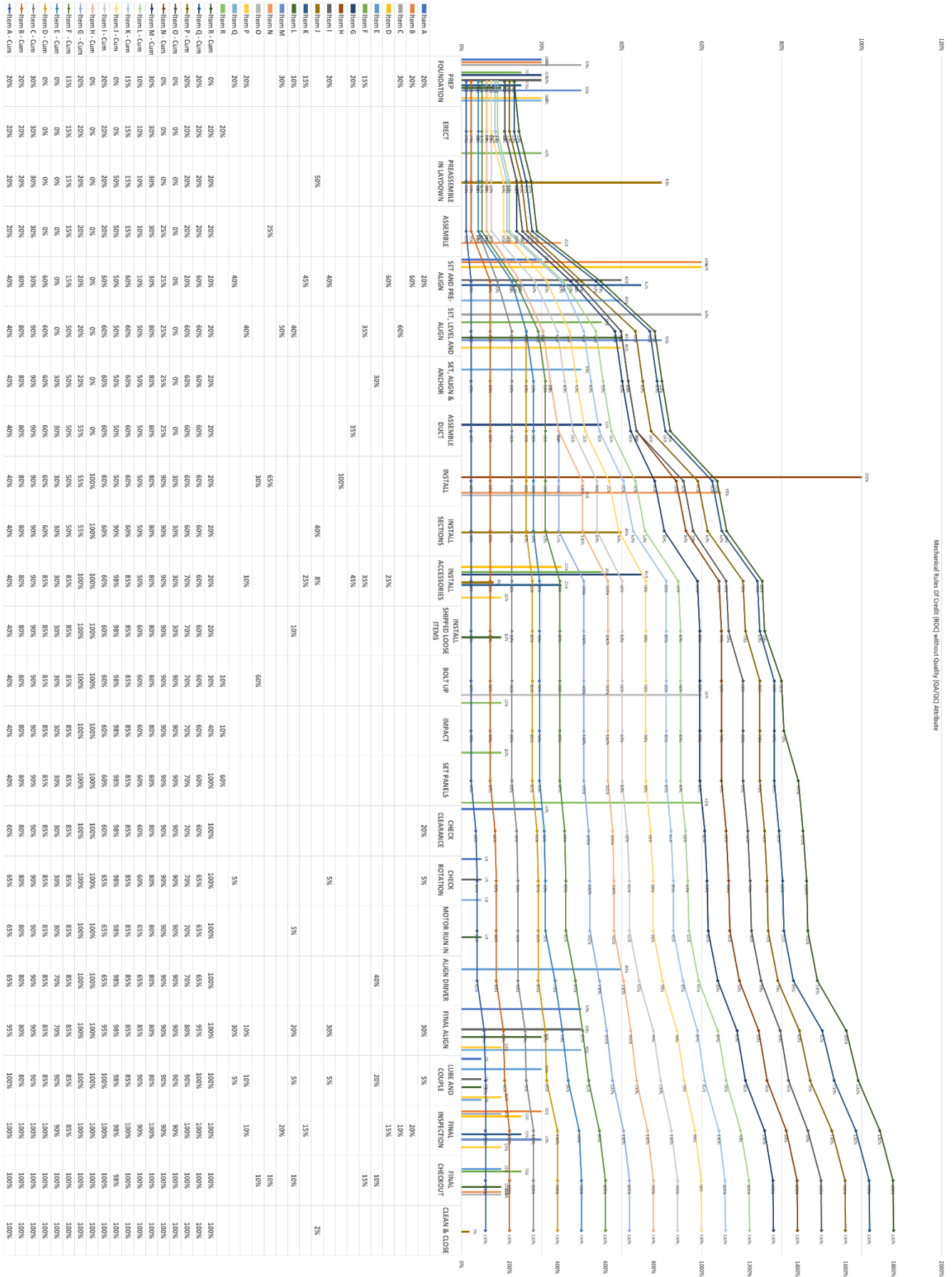
MECHANICAL RULES OF CREDIT (ROC) WITHOUT QUALITY (QA/QC) ATTRIBUTE

	PREP FOUNDATION	ERECT	PREASSEMBLE IN LA YDOWN	ASSEMBLE	SET AND PRE-ALIGN	SET, LEVEL AND ALIGN	SET, ALIGN & ANCHOR	ASSEMBLE DUCT	INSTALL	INSTALL SECTIONS	INSTALL ACCESSORIES	INSTALL SHIPPED LOOSE ITEMS	BOLT UP	IMPACT	SET PANELS	CHECK CLEARANCE	CHECK ROTATION	MOTOR RUN IN	ALIGN DRIVER	FINAL ALIGN	LUBE AND COUPLE	FINAL INSPECTION	FINAL CHECKOUT	CLEAN & CLOSE	Total
Item A	20%				20%											20%	5%			30%	5%				100%
Item B	20%				60%																	20%			100%
Item C	30%				60%																	10%			100%
Item D					60%						25%											15%			100%
Item E							30%												40%		20%		10%		100%
Item F	15%					35%					35%												15%		100%
Item G	20%							35%			45%														100%
Item H									100%																100%
Item I	20%				40%												5%			30%	5%				100%
Item J			50%							40%	8%													2%	100%
Item K	15%				45%						25%											15%			100%
Item L	10%					40%						10%						5%		20%	5%		10%		100%
Item M	30%					50%																20%			100%
Item N					25%				65%														10%		100%
Item O								30%				60%											10%		100%
Item P	20%					40%					10%									10%	10%	10%			100%
Item Q	20%					40%												5%		30%	5%				100%
Item R		20%											10%	10%	60%										100%

MECHANICAL RULES OF CREDIT (ROC) WITHOUT QUALITY (QA/QC) ATTRIBUTE

	PREP FOUNDATION	ERECT	PREASSEMBLE IN LAYDOWN	ASSEMBLE	SET AND PRE-ALIGN	SET, LEVEL AND ALIGN	SET, ALIGN & ANCHOR	ASSEMBLE DUCT	INSTALL	INSTALL SECTIONS	INSTALL ACCESSORIES	INSTALL SHIPPED LOOSE ITEMS	BOLT UP	IMPACT	SET PANELS	CHECK CLEARANCE	CHECK ROTATION	MOTOR RUN IN	ALIGN DRIVER	FINAL ALIGN	LUBE AND COUPLE	FINAL INSPECTION	FINAL CHECKOUT	CLEAN & CLOSE	
Item A - Cum	20%	20%	20%	20%	40%	40%	40%	40%	40%	40%	40%	40%	40%	40%	40%	60%	65%	65%	65%	95%	100%	100%	100%	100%	
Item B - Cum	20%	20%	20%	20%	80%	80%	80%	80%	80%	80%	80%	80%	80%	80%	80%	80%	80%	80%	80%	80%	80%	100%	100%	100%	100%
Item C - Cum	30%	30%	30%	30%	30%	90%	90%	90%	90%	90%	90%	90%	90%	90%	90%	90%	90%	90%	90%	90%	90%	100%	100%	100%	100%
Item D - Cum	0%	0%	0%	0%	60%	60%	60%	60%	60%	60%	85%	85%	85%	85%	85%	85%	85%	85%	85%	85%	85%	100%	100%	100%	100%
Item E - Cum	0%	0%	0%	0%	0%	0%	30%	30%	30%	30%	30%	30%	30%	30%	30%	30%	30%	30%	70%	70%	90%	90%	100%	100%	100%
Item F - Cum	15%	15%	15%	15%	15%	50%	50%	50%	50%	85%	85%	85%	85%	85%	85%	85%	85%	85%	85%	85%	85%	85%	100%	100%	100%
Item G - Cum	20%	20%	20%	20%	20%	20%	20%	55%	55%	55%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Item H - Cum	0%	0%	0%	0%	0%	0%	0%	0%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Item I - Cum	20%	20%	20%	20%	60%	60%	60%	60%	60%	60%	60%	60%	60%	60%	60%	60%	65%	65%	65%	95%	100%	100%	100%	100%	100%
Item J - Cum	0%	0%	50%	50%	50%	50%	50%	50%	90%	98%	98%	98%	98%	98%	98%	98%	98%	98%	98%	98%	98%	98%	98%	98%	100%
Item K - Cum	15%	15%	15%	15%	60%	60%	60%	60%	60%	60%	85%	85%	85%	85%	85%	85%	85%	85%	85%	85%	85%	100%	100%	100%	100%
Item L - Cum	10%	10%	10%	10%	10%	50%	50%	50%	50%	50%	60%	60%	60%	60%	60%	60%	60%	65%	65%	85%	90%	90%	100%	100%	100%
Item M - Cum	30%	30%	30%	30%	30%	80%	80%	80%	80%	80%	80%	80%	80%	80%	80%	80%	80%	80%	80%	80%	80%	100%	100%	100%	100%
Item N - Cum	0%	0%	0%	25%	25%	25%	25%	25%	90%	90%	90%	90%	90%	90%	90%	90%	90%	90%	90%	90%	90%	90%	100%	100%	100%
Item O - Cum	0%	0%	0%	0%	0%	0%	0%	0%	30%	30%	30%	30%	90%	90%	90%	90%	90%	90%	90%	90%	90%	90%	100%	100%	100%
Item P - Cum	20%	20%	20%	20%	20%	60%	60%	60%	60%	60%	70%	70%	70%	70%	70%	70%	70%	70%	70%	80%	90%	100%	100%	100%	100%
Item Q - Cum	20%	20%	20%	20%	60%	60%	60%	60%	60%	60%	60%	60%	60%	60%	60%	60%	65%	65%	65%	95%	100%	100%	100%	100%	100%
Item R - Cum	0%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	30%	40%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%





APPENDIX 2.2:  
MECHANICAL EQUIPMENT INSTALLATION - RULES OF CREDIT - WITHOUT QUALITY ATTRIBUTE - MAN HOURS

Item A	FAN & BLOWER(EA)
Item B	Material Handling Equipment/ Refrigeration Equipment/Special Equipment (Designed Tag Items Only)/ Water/Treatment Equipment (EA)
Item C	Compressors & Dryers/ Exchangers (EA)
Item D	FIRED HEATER&BOILER (EA)
Item F	THERMAL OXIDIZER (EA)
Item G	AUX BOILER (EA)

Manhours		PREP FOUNDATION	ERECT	PREASSEMBLE IN LAYDOWN	ASSEMBLE	SET AND PRE-ALIGN	SET, LEVEL AND ALIGN	SET, ALIGN & ANCHOR	ASSEMBLE DUCT	INSTALL	INSTALL SECTIONS	INSTALL ACCESSORIES	INSTALL SHIPPED LOOSE ITEMS	BOLT UP	IMPACT	SET PANELS	CHECK CLEARANCE	CHECK ROTATION	MOTOR RUN IN	ALIGN DRIVER	FINAL ALIGN	LUBE AND COUPLE	FINAL INSPECTION	FINAL CHECKOUT	CLEAN & CLOSE	Total
5575.86	Item A	1115.17	0.00	0.00	0.00	1115.17	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1115.17	278.79	0.00	0.00	1672.76	278.79	0.00	0.00	0.00	5575.86
2233.7018	Item B	446.74	0.00	0.00	0.00	1340.22	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	446.74	0.00	0.00	2233.70
10688.7659	Item C	3206.63	0.00	0.00	0.00	0.00	6413.26	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1068.88	0.00	0.00	10688.77
9150.7721	Item D	0.00	0.00	0.00	0.00	5490.46	0.00	0.00	0.00	0.00	0.00	2287.69	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1372.62	0.00	0.00	9150.77
98.2829	Item F	14.74	0.00	0.00	0.00	0.00	34.40	0.00	0.00	0.00	0.00	34.40	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	14.74	0.00	98.28
12442.9841	Item G	2488.60	0.00	0.00	0.00	0.00	0.00	0.00	4355.04	0.00	0.00	5599.34	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	12442.98

Manhours		PREP FOUNDATION	ERECT	PREASSEMBLE IN LAYDOWN	ASSEMBLE	SET AND PRE-ALIGN	SET, LEVEL AND ALIGN	SET, ALIGN & ANCHOR	ASSEMBLE DUCT	INSTALL	INSTALL SECTIONS	INSTALL ACCESSORIES	INSTALL SHIPPED LOOSE ITEMS	BOLT UP	IMPACT	SET PANELS	CHECK CLEARANCE	CHECK ROTATION	MOTOR RUN IN	ALIGN DRIVER	FINAL ALIGN	LUBE AND COUPLE	FINAL INSPECTION	FINAL CHECKOUT	CLEAN & CLOSE
5575.86	Item A - Cum	1115.17	1115.17	1115.17	1115.17	2230.34	2230.34	2230.34	2230.34	2230.34	2230.34	2230.34	2230.34	2230.34	2230.34	2230.34	3345.51	3624.31	3624.31	3624.31	5297.06	5575.86	5575.86	5575.86	5575.86
2233.7018	Item B - Cum	446.74	446.74	446.74	446.74	1786.96	1786.96	1786.96	1786.96	1786.96	1786.96	1786.96	1786.96	1786.96	1786.96	1786.96	1786.96	1786.96	1786.96	1786.96	1786.96	1786.96	2233.70	2233.70	2233.70
10688.7659	Item C - Cum	3206.63	3206.63	3206.63	3206.63	9619.89	9619.89	9619.89	9619.89	9619.89	9619.89	9619.89	9619.89	9619.89	9619.89	9619.89	9619.89	9619.89	9619.89	9619.89	9619.89	9619.89	10688.77	10688.77	10688.77
9150.7721	Item D - Cum	0.00	0.00	0.00	0.00	5490.46	5490.46	5490.46	5490.46	5490.46	5490.46	7778.16	7778.16	7778.16	7778.16	7778.16	7778.16	7778.16	7778.16	7778.16	7778.16	7778.16	9150.77	9150.77	9150.77
98.2829	Item F - Cum	14.74	14.74	14.74	14.74	49.14	49.14	49.14	49.14	49.14	49.14	83.54	83.54	83.54	83.54	83.54	83.54	83.54	83.54	83.54	83.54	83.54	83.54	83.54	83.54
12442.9841	Item G - Cum	2488.60	2488.60	2488.60	2488.60	2488.60	2488.60	2488.60	6843.64	6843.64	6843.64	12442.98	12442.98	12442.98	12442.98	12442.98	12442.98	12442.98	12442.98	12442.98	12442.98	12442.98	12442.98	12442.98	12442.98



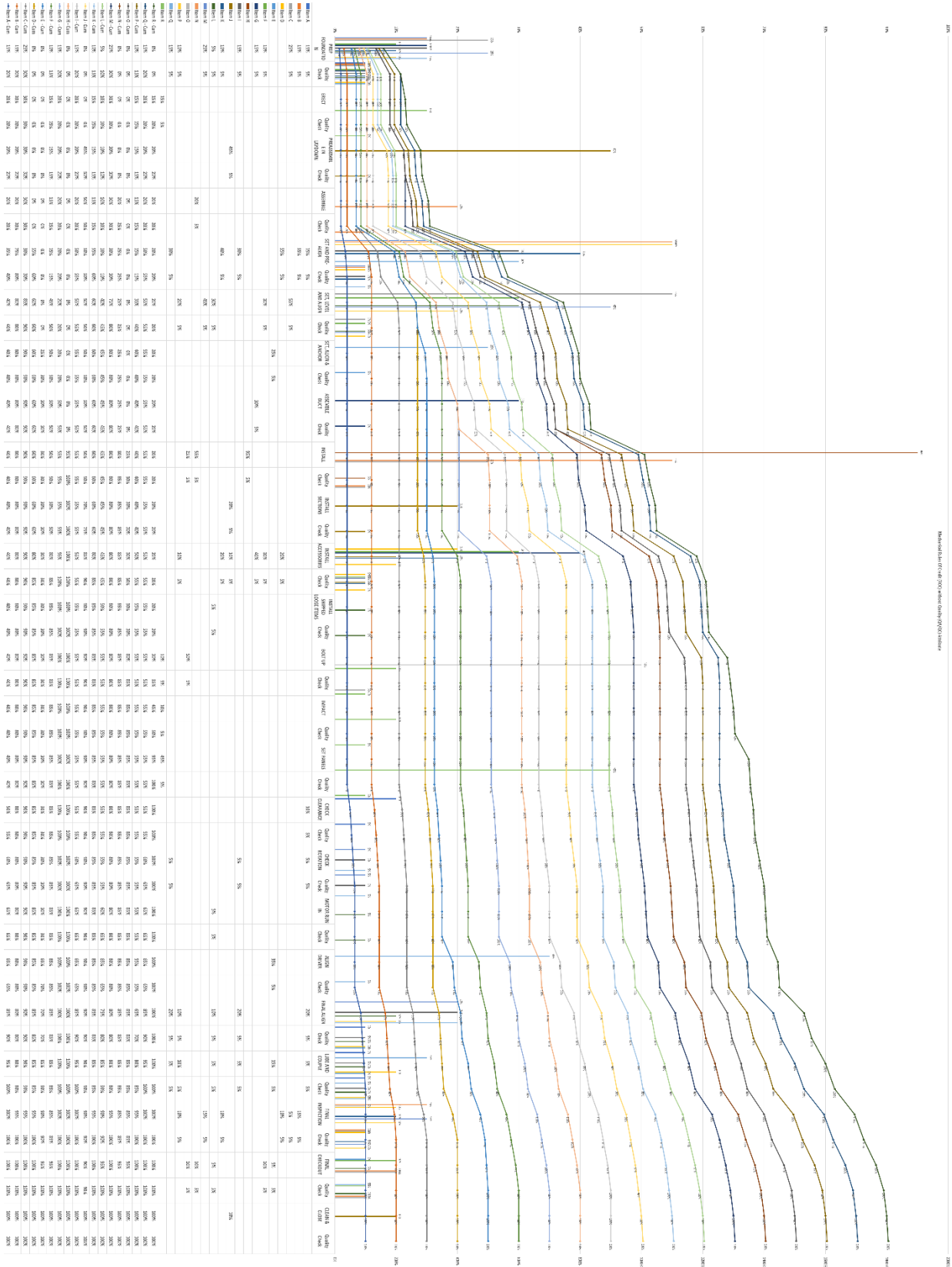


APPENDIX 3.1:  
MECHANICAL EQUIPMENT INSTALLATION - RULES OF CREDIT - WITH QUALITY ATTRIBUTE - %

Item A	FAN & BLOWER(EA)
Item B	Material Handling Equipment/ Refrigeration Equipment/Special Equipment (Designed Tag Items Only)/ Water/Treatment Equipment (EA)
Item C	Compressors & Dryers/ Exchangers (EA)
Item D	FIRED HEATER&BOILER (EA)
Item E	AGITATOR&MIXER (LF)
Item F	THERMAL OXIDIZER (EA)
Item G	AUX BOILER (EA)
Item H	Exchangers/ Flare/ Material Handling Equipment/ Ash Handling System/ Shop Fab Modules/Skids/ Reactors/Towers And Columns/ Water Treatment Equipment (EA)
Item I	SFMS-SKIDS (EA)
Item J	REACTOR (EA)
Item K	GAS STORAGE SYSTEM (EA)
Item L	HOT OIL HEATER PACKAGE (EA)
Item M	GENERATORS/ SPEC EQUIP-SILENCER/ VESSEL (EA)
Item N	MHE-DISCHARGE STATION (EA)
Item O	MHE-BIN ACTIVATOR/VIBRATOR
Item P	MHE - (EA)
Item Q	PUMP-MOTOR
Item R	FLARE (EA)

MECHANICAL EQUIPMENT INSTALLATION - RULES OF CREDIT - WITHOUT QUALITY ATTRIBUTE - MAN HOURS

Item	15%	20%	25%	30%	35%	40%	45%	50%	55%	60%	65%	70%	75%	80%	85%	90%	95%	100%
Item A	PREP FOUNDATION																	
	Quality Check																	
Item B	ERECT																	
	Quality Check																	
Item C	PREASSEMBLE IN LAYDOWN																	
	Quality Check																	
Item D	ASSEMBLE																	
	Quality Check																	
Item E	SET AND PRE-ALIGN																	
	Quality Check																	
Item F	SET, LEVEL AND ALIGN																	
	Quality Check																	
Item G	SET, ALIGN & ANCHOR																	
	Quality Check																	
Item H	ASSEMBLE DUCT																	
	Quality Check																	
Item I	INSTALL																	
	Quality Check																	
Item J	INSTALL SECTIONS																	
	Quality Check																	
Item K	INSTALL ACCESSORIES																	
	Quality Check																	
Item L	INSTALL SHIPPED LOOSE ITEMS																	
	Quality Check																	
Item M	BOLT UP																	
	Quality Check																	
Item N	IMPACT																	
	Quality Check																	
Item O	SET PANELS																	
	Quality Check																	
Item P	CHECK CLEARANCE																	
	Quality Check																	
Item Q	CHECK ROTATION																	
	Quality Check																	
Item R	MOTOR RUN IN																	
	Quality Check																	
Item S	ALIGN DRIVER																	
	Quality Check																	
Item T	FINAL ALIGN																	
	Quality Check																	
Item U	LUBE AND COUPLE																	
	Quality Check																	
Item V	FINAL INSPECTION																	
	Quality Check																	
Item W	FINAL CHECKOUT																	
	Quality Check																	
Item X	CLEAN & CLOSE																	
	Quality Check																	
Total																		



APPENDIX 3.2:  
MECHANICAL EQUIPMENT INSTALLATION - RULES OF CREDIT - WITH QUALITY ATTRIBUTE - MAN HOURS

Item A	FAN & BLOWER(EA)
Item B	Material Handling Equipment/ Refrigeration Equipment/Special Equipment (Designed Tag Items Only)/ Water/Treatment Equipment (EA)
Item C	Compressors & Dryers/ Exchangers (EA)
Item D	FIRED HEATER&BOILER (EA)
Item F	THERMAL OXIDIZER (EA)
Item G	AUX BOILER (EA)



