DCU REVAMP FOR CAPACITY AND EFFICIENCY INCREASE

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A Chevron and Lummus Technology Joint Venture

Overview

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Unit Introduction

- Unit Design Capacity : 1.36 MMTPA or 170,000 kg/h (23,500 BPSD)
- Refinery : Bharat Oman Refineries Limited (BORL), Bina, India
- Commissioned : 2011
- Licensor : Chevron Lummus Global (CLG)
- Detailed Engineering Company : Engineers India Limited (EIL), New Delhi, India

Unit Introduction

- Feed Design Basis :

Feed Property Vacuum Residue	Feed-1 (100% Kuwait)	Feed-2 (65:35 wt% Arab Mix)	Feed-3 (45:55 wt% Arab Mix)	Feed-4 (100% Oman)
API - Gravity	4.53	4.18	3.77	11.99
Sulfur	5.50	5.19	5.50	2.52
Asphaltenes	21.0	N/A	N/A	1.8
CCR, wt%	22.30	23.99	25.04	15.62

- Extraneous streams :
  - ✓ a) Filter backwash stream from the hydrocracker
  - ✓ b) Black slop from refinery
  - ✓ c) Refinery sludge from ETP

Unit Introduction

- Products :
  - Coker Fuel Gas
  - Liquefied Petroleum Gas
  - Coker Naphtha (C_5 - 140°C)
  - Light Coker Gas Oil (140°C - 370°C)
  - Heavy Coker Gas Oil (370°C Plus)
  - Coke

Unit Introduction

- Unit Special Design Features :
  - Two heaters for one pair of coke drums
    - ✓ Provision of on-line pigging
    - ✓ Isolations at inlet and outlet
    - ✓ On-line spalling

DCU Revamp

- After successful operation of the DCU at design levels, BORL noted the potential to further enhance the capacity of the unit
- The unit revamp was planned out in the three phases :
  - Phase I - Revamp Feasibility Study - *To identify alternatives and estimate capacity increase and energy saving - Completed*
  - Phase II – Comprehensive process engineering for phase I and in-depth mechanical design critical items - *Completed*
  - Phase III - Detailed Engineering, Procurement and Construction - *On-going*

DCU Revamp
Objectives

- The main objective was to increase DCU throughput by 30% by :
  - Utilizing inbuilt equipment design margins
  - Paying attention to current operating conditions
- Other considerations :
  - Short shutdown period
  - Low revamp cost

DCU Revamp
Design Basis

- Design Basis :
  - Capacity Increase : 170 MT/h to 220 MT/h (23,500 BPSD to 30,550 BPSD)
  - On-Stream Factor Increase : 8,000 hours/year to 8,280 hours/year
  - Turndown 50%
  - Revamp Feed Case :

Feed Property Vacuum Residue	Feed Case - 1 45:55 Arab Mix	Feed Case - 2 48% Arab Mix (65:35 Blend of Arab Light : Arab Heavy) + 52% Oman
API Gravity	4.53	7.18
Sulfur, Wt%	6.0	4.12
Asphaltenes, Wt%	12.3	9.1
Con Carbon, Wt%	27.0	22.0

Revamp Feasibility Study

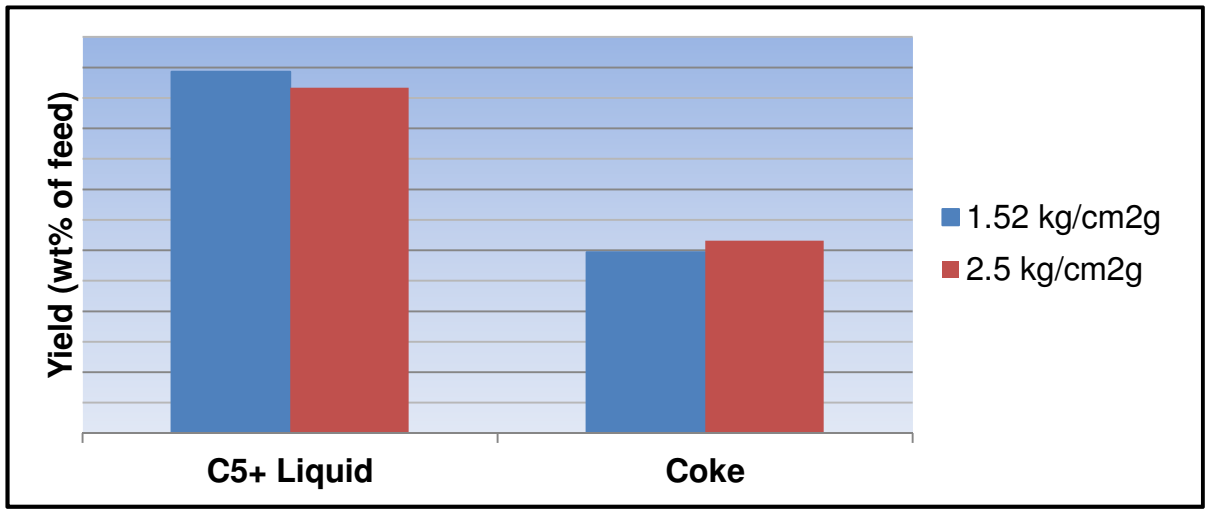
- Unit Test Run
  - Determination of maximum achievable capacity
  - Validation of the CLG in-house Yield Prediction model
- Equipment adequacy
  - Coke Drum
  - Thermal rating of Coker Heater
  - Other Equipment
- Plot plan availability
- Project schedule
- Revamp Total Investment Cost (+/- 30%)

Revamp Feasibility Study
Coke Drum

- Original design coke drum overhead pressure : 1.05 kg/cm²g
- Due to system hydraulics, a minimum coke drum overhead pressure of 1.52 kg/cm²g is required for 130% throughput, however the superficial velocity exceeds the design limits at these conditions
- To meet the superficial velocity design criteria, a higher coke drum overhead pressure of 2.5 kg/cm²g is required
- Higher pressure coke drum operation will decrease liquid yield and increase coke make

Revamp Feasibility Study
Coke Drum

- C_5^+ Liquid and Coke yield - 1.52 kg/cm^{2}g vs 2.5 kg/cm^{2}g operation



- The increase in pressure results in a C_5^+ liquid yield loss (~ 2 wt.%) equivalent to about 12 MMUSD/year
- Hence, there was merit in investigating options of retaining lower coke drum overhead pressure

Revamp Feasibility Study
Coke Drum

- To retain lower coke drum pressure, the addition of a single new coke drum vs. another pair of coke drums was studied
- The benefits of adding a new single drum vs. another pair of coke drums are :
  - Lower investment cost
  - Less plot area required
  - Longer decoking time (30-hour), thus no change in the blowdown section
  - Higher vapor disengagement space in each coke drum

Based on the above, it was decided to install a single new coke drum.

CB&I's Vertical Plate Coke Drum Technology (VPCD) was selected for the new drum.

Revamp Feasibility Study
Coke Drum

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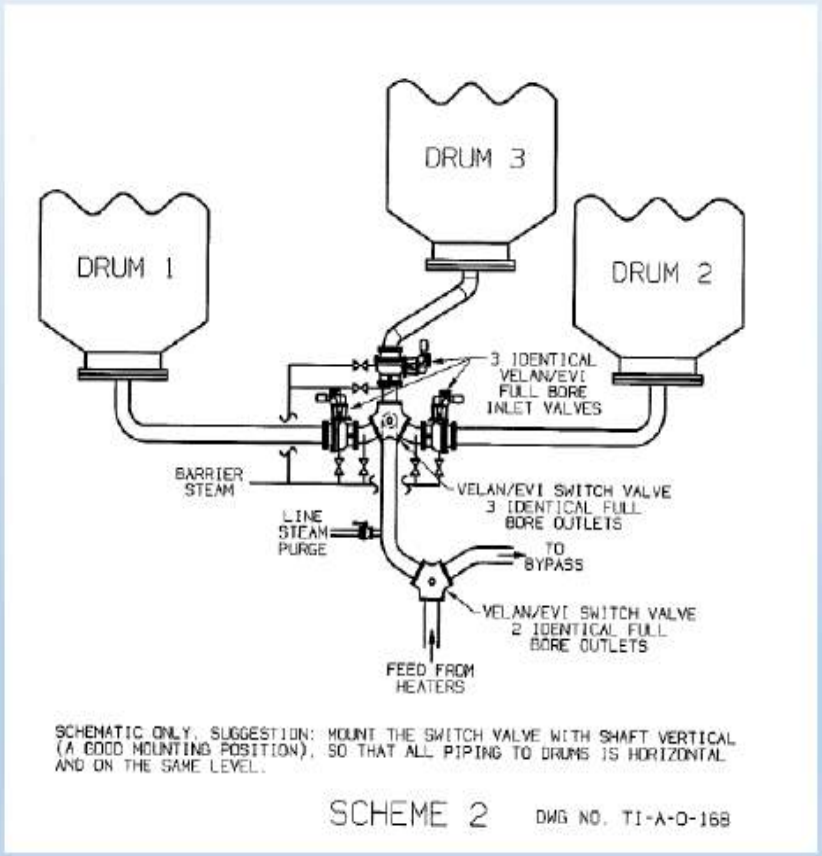
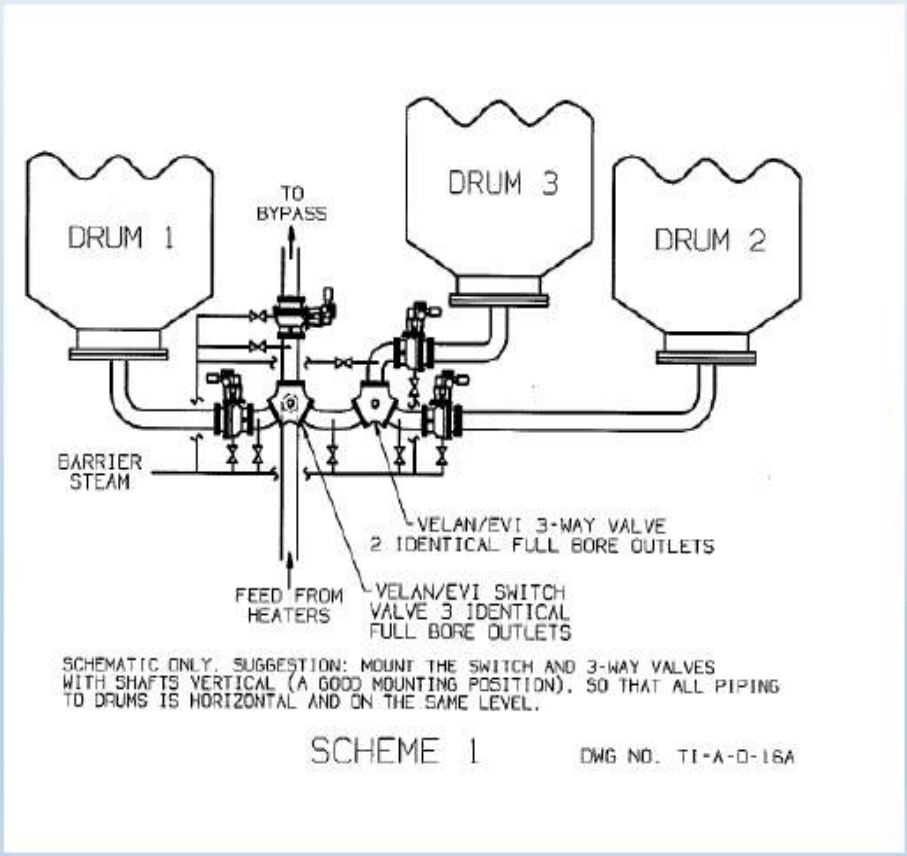
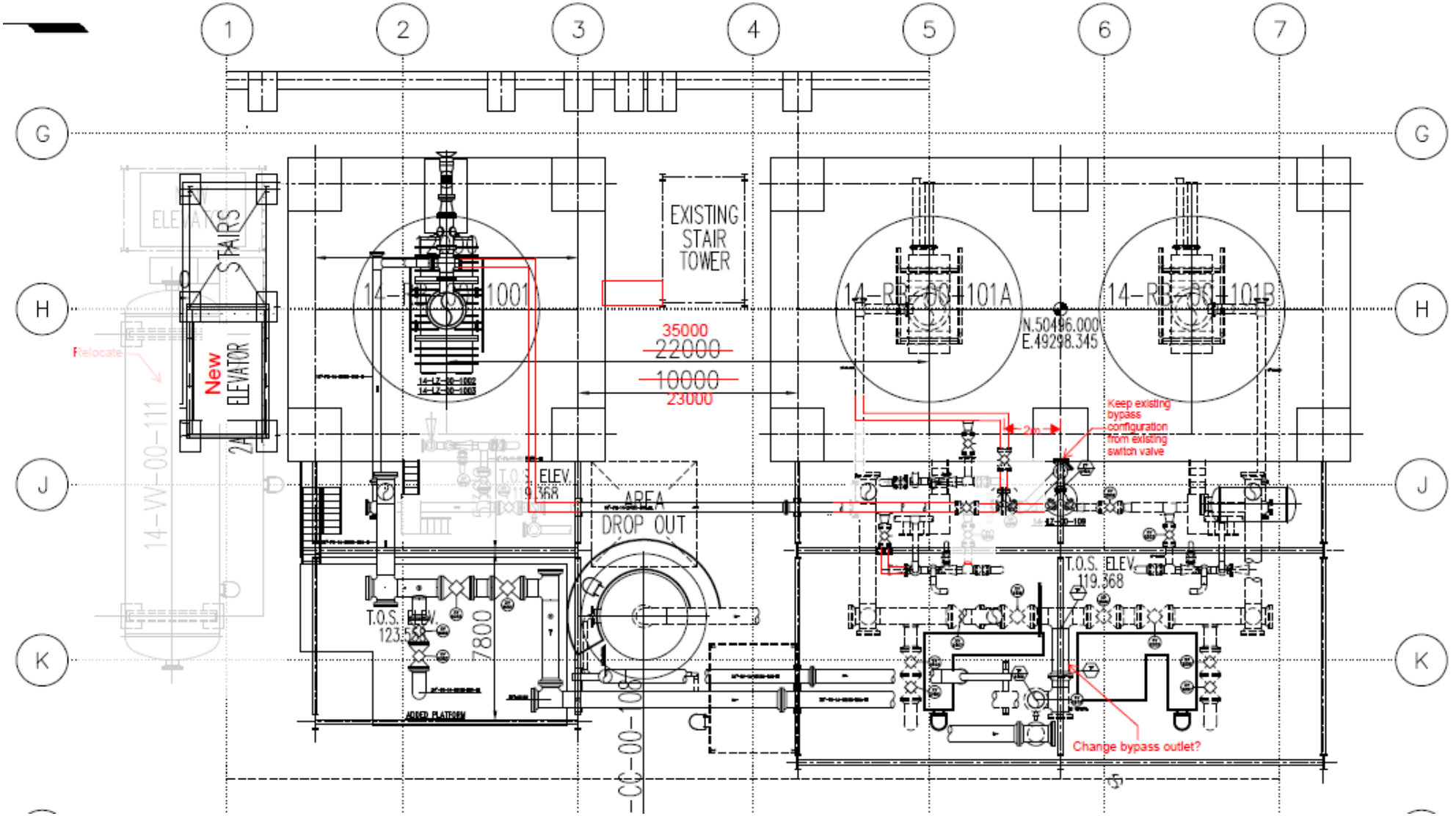
Typical Layouts of Switch Valves in a 3 Drum arrangement





Revamp Feasibility Study
Coke Drum



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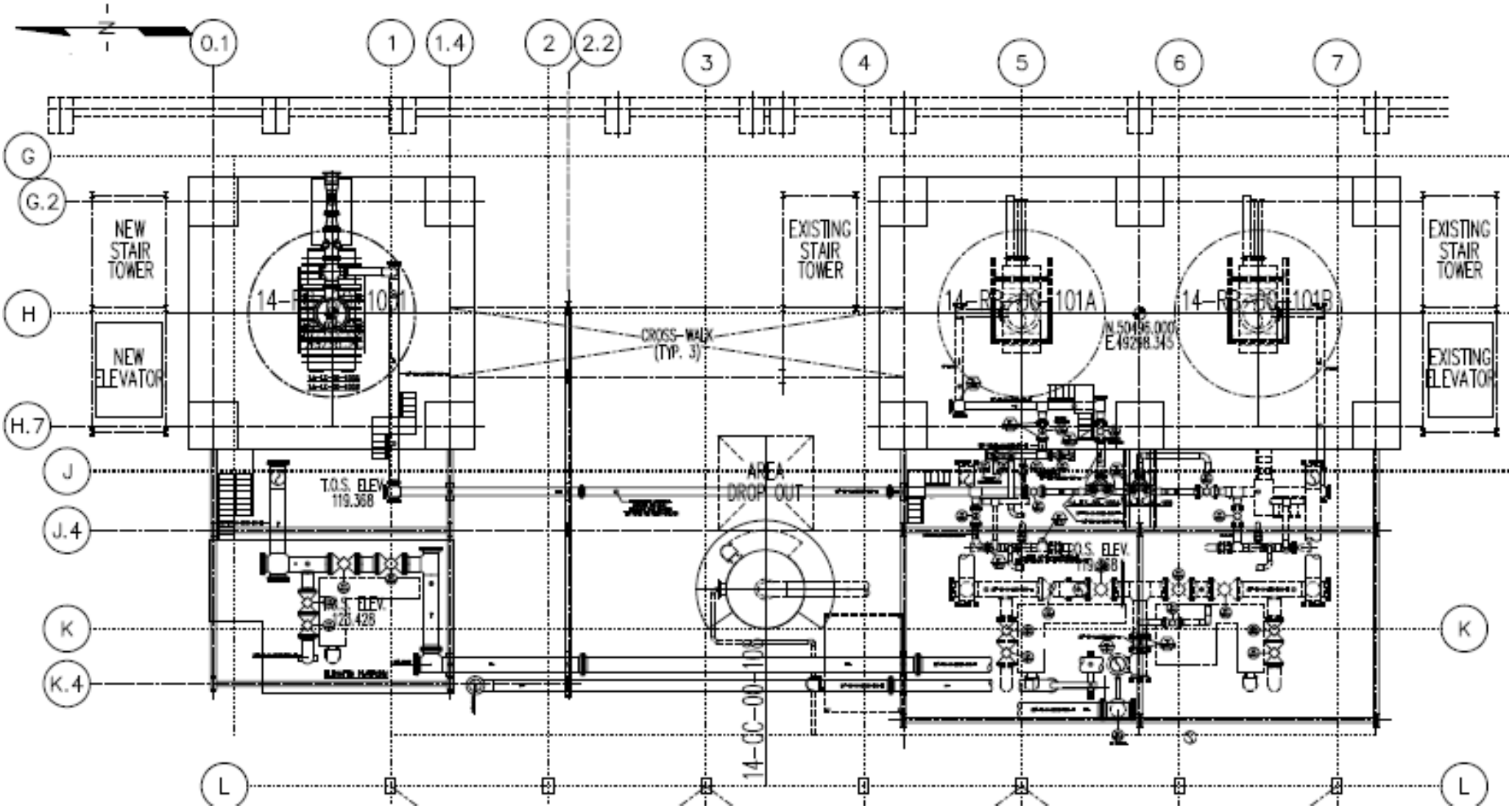
Coke Drum



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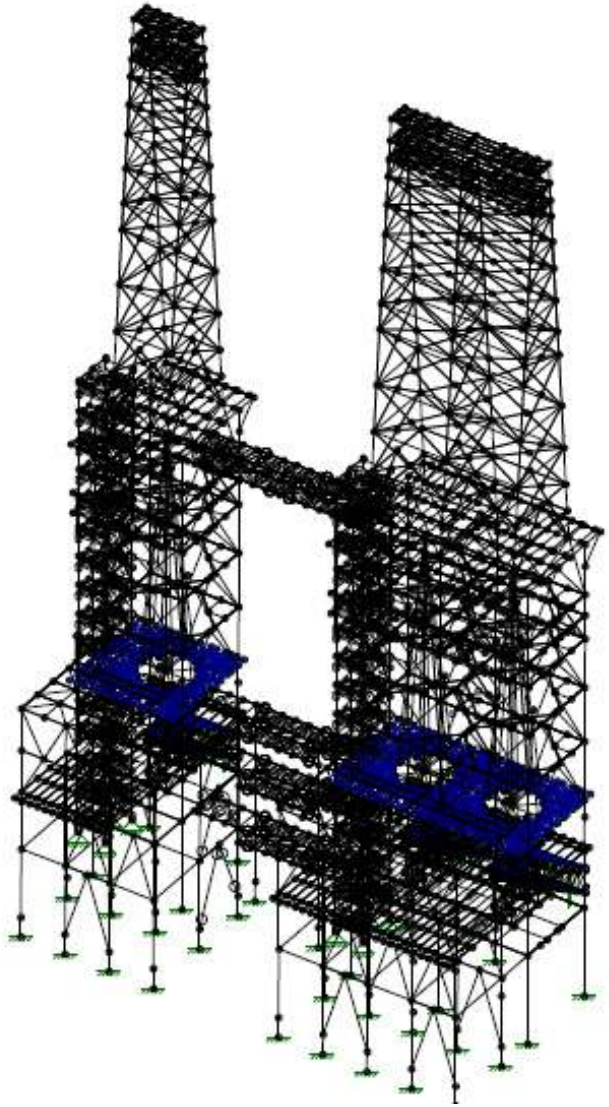
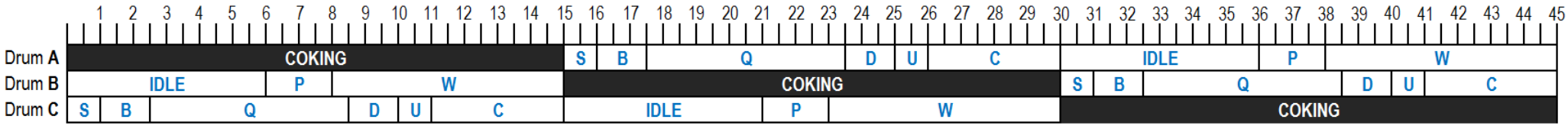
Coke Drum



Revamp Feasibility Study
Coke Drum

- Coking / Decoking Schedule (45-Hour Cycle)



Key	Hrs	Operation
	15	Coking
S	1	Steamout to Fractionator
B	1.5	Steamout to Blowdown
Q	6	Quench and Fill
D	1.5	Drain
U	1	Open Heads
C	4	Hydraulic Decoking
IDLE	6	Idle Time
P	2	Re-head & Pressure Testing
W	7	Drum Warm-up
	45	Total Cycle

Revamp Feasibility Study
Coker Heater

- Thermal rating of the Coker Heater was carried out for the revamp conditions
- Modifications proposed :
  - Add roof tubes to each cell to keep the radiant flux within the allowable limit
  - Change tube number, size, and metallurgy of radiant tubes
    - Allows an increase in the End of Run (EoR) Tube Metal Temperature (TMT), leading to an increase in run length
    - Causes EoR pressure drop to be within the allowable limit, minimizing the modifications in the heater charge circuit
  - Replace tube supports

Revamp Feasibility Study
Coker Heater

- Modifications proposed (cont.) :
  - Use two future rows of tubes in the convection section
  - Replace both forced draft and induced draft fans to accommodate higher flow and static pressure
  - Reuse the existing burner with new tip drillings and new oil gun
- Preliminary rating of Air Preheater reveals no modification is required. However, further rating of the APH is to be carried out by the supplier during detailed engineering phase of the project
- Combustion air, flue gas ducts and stack – No modification required

Revamp Feasibility Study
Equipment Adequacy Check

- Equipment Adequacy :
  - Wet Gas Compressor : A new wet gas compressor to be installed in parallel with existing WGC
  - Columns : Diameters are adequate, internals require modifications
  - Pumps : Larger impeller installation was recommended, new pumps if required
  - Shell and tube heat exchangers : Rated based on simple UA analysis
  - Air coolers : Rated using CLG in-house rating program
  - Hydraulics carried out in next phase

Revamp Feasibility Study
Proposed Modifications

- Other proposed modifications :
  - Water Ring Compressor : To be installed on the blowdown overhead circuit to minimize emission and depressurize the coke drum safely
  - Fresh Feed Steam Preheater : To be installed on the fresh feed line to accommodate for temperature fluctuations in the fresh feed to the DCU
  - Coke Pit/Pad : Extension of pit/pad to allow for increase in coke make
  - Center Feed Device (CFD) : New coke drum feed piping configuration has been designed considering the installation of a CFD in the future if deemed necessary

Revamp Feasibility Study
Proposed Modifications

- Other revamp feasibility considerations :
  - Plot plan availability for the new / modified equipment
  - Revamp project schedule – 40 days
  - Budgetary TIC cost estimate (+/-) 30%

Based on the results of the feasibility study, BORL has decided to further pursue the revamp of the unit.

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Conclusion

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- Delayed Coking units add a lot of flexibility to a refinery operation. It is one of the most versatile units in terms of “its ability to process a broad range of” feed quality.
- The refiner can shift the product slate to a different type of coke or to a different yield structure based on shifts in the market demand, with minimal changes to the unit infrastructure.
- Selecting a revamp option should be done carefully, considering the minimization of capital investment and maximization of return. This requires a vast knowledge of the technology and experience in project execution.
- A successful DCU revamp must be done in a planned manner, with a close working relationship between the Licensee, Detailed Engineering Company, and Licensor.

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Thank you

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