MANAGING STEAM GENERATOR EXCESS UNITS AT PT. YKL

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Purpose - This paper is to apply lean principles to eliminate excess steam generators in the company. A multifunctional team which has a strong knowledge on process, simulation tools, and broad projects knowledge were involved.

Methodology/Approach – PT. YKL has five steam stations for running its business, extracting oil from its reservoir. The steam stations are home for 218 steam generators units. As its oil reservoirs mature, naturaly the reservoirs require less steam. As the demand drops, PT. YKL needs to balance the supply. As a result, they have excess number of steam generators. They are initially identified it by collecting the unit's allocation for maintenance and other shutdown issue per steam stations. This available-unit less maintenance-allocation shows the true steam generators supply capability. On the demand side, PT. YKL also looked at its demand forecast profile in the years to come. Defining the excess unit per steam station limits the number of excess unit they can eliminate. To maximize it, PT. YKL totally changed the way they defined the excess. By collecting all the excess in once steam station, they can maximize the number of excess. However, they need to ensure that the remaining steam generators can satisfy the customer's requirements (in term of flow and pressure). Here simulation tools played its key role.

Findings - It was found the implementation of this lean initiative was successfully decommissioned 46 excess steam generators from 218 steam generators.

Research limitations / implications: The simulation tool could not exactly represent the actual key process parameters. Site tweaking was stil needed to adjust the key process parameters to achieve the expected performance measures.

Value – Limiting the boundaries to define the number of steam generator excess reduce the number of excess unit PT. YKL can claim. By creatively enlarging the boundaries definition to beyond steam station level maximize the number of excess PT. YKL can claim. The project was successfully booked Total Accrued Financial Benefit is $ 5 MM.

Key words: lean principle, beyond boundaries, collaboration

1. Introduction

PT. YKL is one of Oil and Gas Company in Indonesia. To extract oil from its reservoir, the company utilized steam. There are two main steam producers (see figure 1) as sources of steam; Waste Heat Recovery Units (WHRU) and Steam Stations (SS). WHRU produces steam by absorbing effluent gas from gas turbine combustion. There are two WHRU types installed in PT. YKL, WHRU type-1 (WHRU-T1) and WHRU type-2 (WHRU-T2). The first type is smaller capacity, while the later capacity is 12 times bigger. On the other hand, steam stations make steam by using a dedicated combustion process. Steam stations are home for steam generators, which commonly known as boiler.

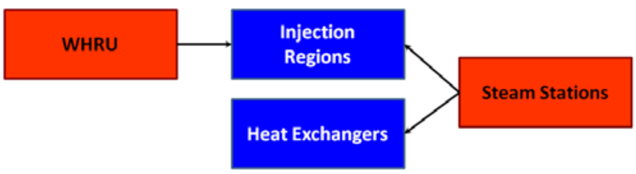

Figure 1. Steam sources and its utilization in PT. YKL

Injection Regions and Heat Exchangers steam usages represent the steam demand side. Steam for Heat Exchangers' consumption tends to contants all the time. Currently, it only represents 4% of the whole steam demand. However, the biggest part of the demand is from Injection Regions. As the oil reservoirs become mature, steam supply to injection regions needs to be reduced. While otherwise will exposing the company to huge fuel cost for steam production. As the demand drops, there will be an excess installed steam capacity. In this paper, we will discuss the strategy implemented to reduce this excess steam capacity. We focus our decommissioning efforts to steam stations as steam generator is less efficient when it is compared to WHRU (Silverberg, 1997).

2. Framework

To determine the number of excess steam generator units, it needs to identify total steam produced and the total steam demand. We identify the excess generator by implementing the framework in figure 2 below. If all steam generators are up and running, its total nameplate capacity will same with its capacity as stated on its individual steam generator nameplate times the total units. However, there are always conditions that steam generators are down due to many reasons such as broken parts, general inspection and certification requirement, etc. If the total nameplate capacity is allocated for units downs, its available (operating plus standby) units are named as baseline capacities. Further allocation this baseline capacity to Heat Exchangers use, to meet steam demand from Injection Regions, and to anticipate for one WHRU-T2 down will determine the steam generator excess capacity. Dividing this excess capacity to unit of steam production per steam generator will then yield the number of steam generator unit for permanent shutdown.

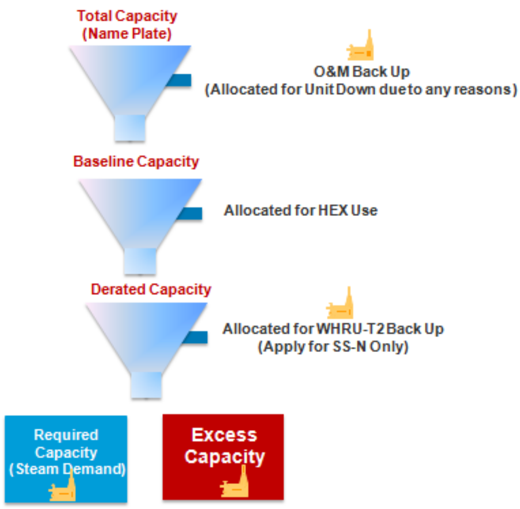

Figure 2. Identifying the excess steam generator units

3. Steam Supply and Demand

3.1 Steam Producers Profiles

The guaranteed steam demand profiles need to be determined to ensure that steam demand is always met. Table-1 below summarizes the capacity of each steam producers in normalized unit capacity. This normalized capacity unit is actually steam mass flow rate. It was made dimensionless to make it simpler for the readers from non-engineering degree to help them focus on the problem instead of dealing to technical detail. However, the data herein came from original site data. Nameplate capacity is the capacity of steam producers as stated on its respective nameplate. The nameplate is normally installed somewhere on the machine body. Steam Stations are consists of four stations, SS-S (Steam Station South), SS-C (Steam Station Center), SS-E (Steam Station East), and SS-N (Steam Station North).

Table-1. Steam Producers number of units and its total nameplate capacity

Producers	No of Units (pcs)	Total Nameplate Capacities (in normalized units)
SS-S	28	980
SS-C	46	1,610
SS-E	46	1,656
SS-N	98	3,528
WHRU-T2	3	3,600
WHRU-T1	6	540

By collecting unit down data from steam producers, reliable capacity can be estimated. Table-2 below shows number of down unit from week-1 to week-6 of steam stations. Such data is the starting point for determining the available capacity per steam stations. In this paper, there were three months data were collected, each year. The conservative data was then taken for safety factor.

Table-2 Raw data sample of steam generators down data.

Steam Stations	Number of Unit Down					
	Week-1	Week-2	Week-3	Week-4	Week-5	Week-6
SS-S	2	2	2	2	2	2
SS-C	3	3	3	3	3	3
SS-E	4	4	4	4	4	4
SS-N	7	7	7	7	7	7

WHRU type-1 and type 2 down data characteristic was not provided herein since it owned by different business unit in PT. YKL. For this purpose, its final data is only collected. However, its calculation principles are the same as shown below on data processing section below.

3.2 Steam Demand Data.

Steam Demands is derived from Injection Regions Steam Demand and Heat exchangers. Tabel 3 shows steam injection demand forecast by Injection Regions. In the table, it shows Reg-A, Reg-B, Reg-C, etc. For example, Reg A. It means Injection Region-A. Table 4 shows heat exchanger consumption and potential steam producers which supply each of those.

Tabel-3 Steam Demand by Injection Regions (Region-I and Region-O are not exist)

STEAM DEMAND BY INJECTION REGIONS (NORMALIZED UNITS)													
Reg-A	Reg-B	Reg-C	Reg-D	Reg-E	Reg-F	Reg-G	Reg-H	Reg-J	Reg-K	Reg-L	Reg-M	Reg-N	Reg-P
48	113	909	493	618	575	583	654	322	436	516	468	986	186

Table-4 Heat Exchanger Demands and its Supplying Steam Producers

Descriptions	POTENTIAL STEAM PRODUCERS TO FEED HEX			
	SS-S	SS-C/WHRU-T1	SS-E/N	WHRU-T2
HEX Consumption (in normalized units)	80	50	50	100

4. Data processing

4.1 Determination of Steam Generators unit downs

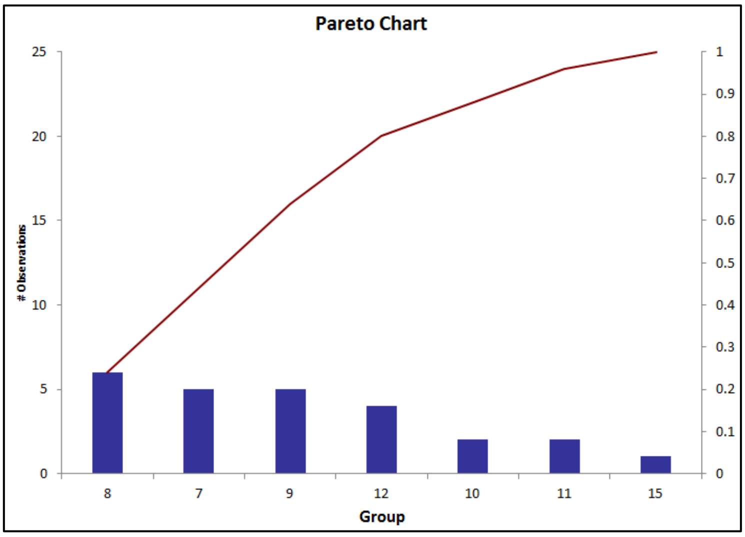

Figure 4. Determining Steam Station SS-N allocated units down for any reasons

Pareto chart approaches is used to get the estimate number of unit downs. Use of averages approaches is also possible. However, it does not reflect the most expected values. From three months down data just like shown in table-3, the Pareto Chart was generated by SPC-XL tools. Figure-4 is the Pareto Chart of SS-N down data. The vertical axis shows the frequency. The horizontal axis is the number of steam generators units down in the same time. The other vertical axis on the right shows the percentage. For example, during 3 months observation period, there were 6 times SS-N experienced 8 units down in the same time. Pareto chart above then transformed into table as shown below, three quartiles from the data was then taken which represents P10, P50, and P90. Quartile approaches was very popular in PT. YKL (DA Class, 2012). P10 means that 10% of the population will experience shutdown of less or equal with 7 unit downs. P50 means that 50% of the population will experience shutdown of 9 units or less. P90 means that 90% of the population will experience shutdown unit in the same time of 12 units or less. SS-N expected down unit will represent the number of down unit of the station. This expected hereinafter is signed as EV value. EV SS-N is equal with 25%*P10 + 50%*P50 + 25%*P90. EV SN is equal with the roundup of 25%*7+50%*9+25%*12, 9.25 unit down in the same time. If SS-N steam generator unit is 98 units, the the guaranteed capacity of the station will be 91%. Table-7 shows the baseline percentage of SS-N. Others steam stations use the same calculation principles. Table-7 shows the baseline values.

Tabel 5. Use of SPC-XL tool to identify P10, p50, and p90 in SS-N

SS-N (# of Unit Down)					
Group	Count	Invididuval Event (%)	Commulative (%)	Quartile	Down #
7	5	20.0%	20.0%	p10	7
8	6	24.0%	44.0%		
9	5	20.0%	64.0%	p50	9
10	2	8.0%	72.0%		
11	2	8.0%	80.0%		
12	4	16.0%	96.0%	p90	12
15	1	4.0%	100.0%		

Table-7. Baseline capacity per steam station after considering number of unit down. This base line impacts the guaranteed capacity and its equivalent unit.

Steam Station	Number of Units	Total Name Plate Capacity (Normalize Unit)	Baseline Availability (%)	Baseline Capacity (Normalized Unit)	Equivalent Unit
SS-S	28	980	82%	805	23
SS-C	46	1,610	87%	1,400	40
SS-E	46	1,656	89%	1,476	41
SS-N	98	3,528	91%	3,204	89

Derated capacity is the baseline capacity after accounting for heat exchanger use. HEX charge to steam producers may be directed to other limited sources, as mentioned in table 4. The derated capacity is the capacity available for injecting Injection Regions.

Tabel-8 Combine table-7 for HEX use with baseline capacity shows the derated capacity.

Steam Producers	Baseline Capacity (Normalized Unit)	HEX Use (Normalized Unit)	Derated Capacity (Normalized Unit)
SS-S	805	80	725
SS-C	1,400		1,400
SS-E	1,476	100	1,376
SS-N	3,204		3,204
WHRU-T2	3,188	100	3,088
WHRU-T1	380		380

4.2 Matching Steam Supply and Demand

It has been been identified on the previous section that it is impossible to assume all steam generators ready for operations. The calculation provided allowance for unit downs based on actual data. It was then statistically processed to gain a good estimate the number.

Dispatching principles were used as guides to get excess units. Steam producers and its customers connected by steam dispatching networks, where every steam producers and injection regions being its main components beside the steam piping system. Every scenarios or alternatives were then modelled by simulation tools to justify its dispatchability. The following are the steam dispatching principles employed by PT. YKL:

- Every scenario or alternatives should optimize WHRU-T2 use for the northern part of the oil field.
- Maximize WHRU capacity utilization, since it has better steam to fuel ratio.
- Use the nearest steam source as much as possible
- Optimizing SS-S units since it has better efficiency when it compares with other steam stations.

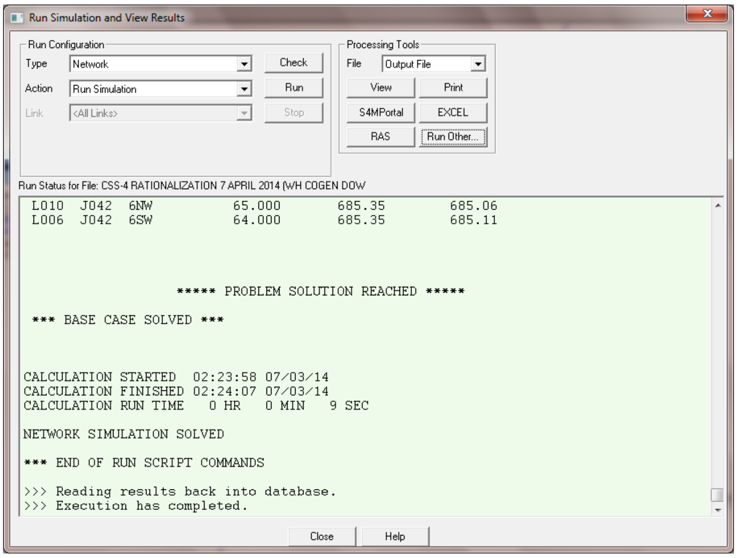

Figure 5. Simluation tools interface when calculation is underway.

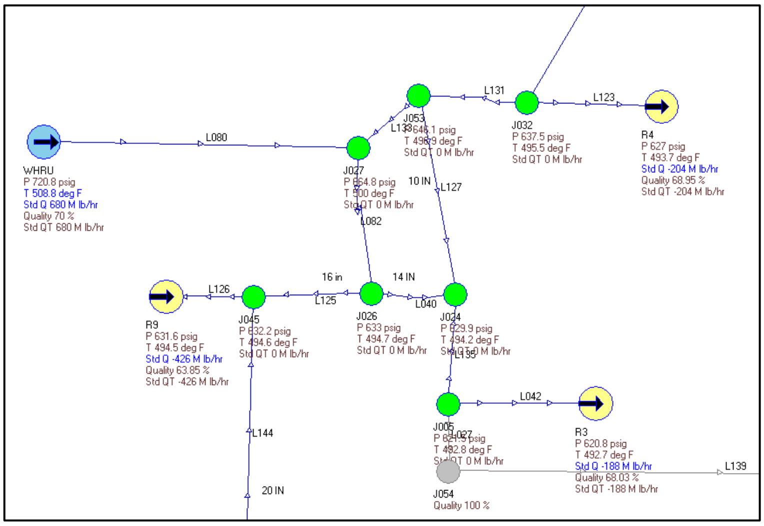

Figure-6 Simulation tool are showing the calculation example which will ensure the matching between supply and demand.

There are many alternatives scenario to define excess unit distribution. Here, it will be discussed two prominent alternatives for defining the excess and its distribution. Table 9 shows the first alternative. It assumes that every steam producers will be maintained. As a results, it can be seen that every steam produces have excess shares. Table 10 shows the second alternative. Instead of distributing excess in every steam producers, it pools all the excess at once steam station, SS-E (highlighted to increase visibility). Since the steam station is put on down, all capacity under “Required Capacity” tab, is shared to others steam producers. It makes excess units in other steam producers is much lower when it compares with its first alternative.

Table 9 PT. YKL Steam dispatching with all load distributed in all steam producers.

Steam Producers	Derated Capacity	Required Capacity	REGIONAL STEAM DISTRIBUTION (Normalized Unit)														Excess Capacity
			REG-A	REG-B	REG-C	REG-D	REG-E	REG-F	REG-G	REG-H	REG-J	REG-K	REG-L	REG-M	REG-N	REG-P	
SS-S	725	631	48						583								94
SS-C	1,350	829			773							56					521
SS-E	1,476	1,111				493	618										365
SS-N	3,154	2,309		113	136			567		654	322		516				845
WHRU-T2	2,026	1,640												468	986	186	385
WHRU-T1	380	380										380					

Note: All capacities are in Normalized Units

Table-10 PT. YKL Steam Dispacthing when pooling all excess in SS-E

Steam Producers	Derated Capacity	Required Capacity	REGIONAL STEAM DISTRIBUTION (Normalized Unit)														Excess Capacity
			REG-A	REG-B	REG-C	REG-D	REG-E	REG-F	REG-G	REG-H	REG-J	REG-K	REG-L	REG-M	REG-N	REG-P	
SS-S	725	631	143						488								94
SS-C	1,350	1,322			773	493						56					28
SS-E	**1,476**																
SS-N	3,154	2,926		113	136		618	567		654	322		516				228
WHRU-T2	2,026	1,640												468	986	186	385
WHRU-T1	380	380										380					

Note: All capacities are in Normalized Units

5. The Solution and the Benefits

Criteria should be made to select the best alternative among two. The alternative which brings the most value will be selected. Figure 8 shows the combination between required units for meeting the steam demand, unit down allocation, and the excess units for the first alternative. The first alternative needs maintain four steam stations. Figure 9 shows the second alternative but has the same composition at three steam stations. The combination between the required units and the excess units for the first and the second alternative may have slightly different quantity. Maintaining four steam stations instead of three steam stations require much higher supporting facilities. Upon further investigation, there were potential alignments with other two projects. The first project needed to build facilities for water disposal. Converting the steam station into a disposal facility may help the company saving for capital investment. The second project was retrofit project. In the last two years, the reftrofit project has come to final investment decision which was applicable to SS-C and SS-E. The total investment approved for retrofit projects required 10 Million USD.

The decision to shutdown one of those stations helped PT.YKL avoided another unnecessary investment. Each steam generator also needs certification in every 2 years. It costs PT. YKL USD 25,000 to USD 30,000 per steam generators (Company Data on Steam Generator Cost). Shutting down 46 units will avoid this cost potential as well. Nother benefit from this decision was that allocation of man power. If it was previously SS-E required 16 people to operate the stations, PT. YKL was then able to allocate this manpower to other facility without going into formal hiring process. There was also safety impact from this decision. Start-up and shutdown activities were the crotcal parts of the operation of the units. It was just like operating airplane, where landing and take off were its most critical parst during the filght. In every 5 days, equipment standard operating procedures call for unit rotation (Company Standard Operating Procedure). Eliminating the number of excess unit reduces the leklihood of incidents.

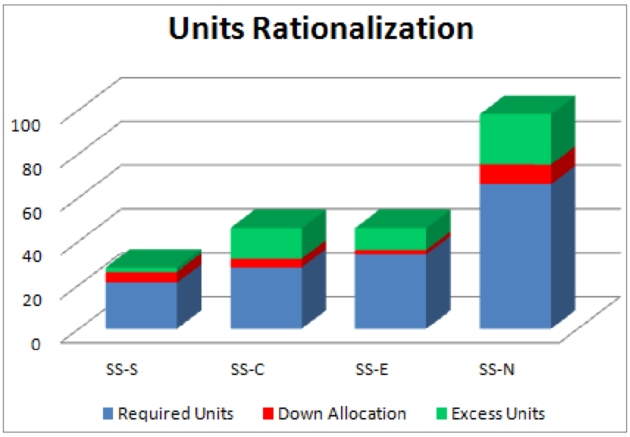

Figure 8 Excess Steam Generator Units when all the excess distributed in every steam stations

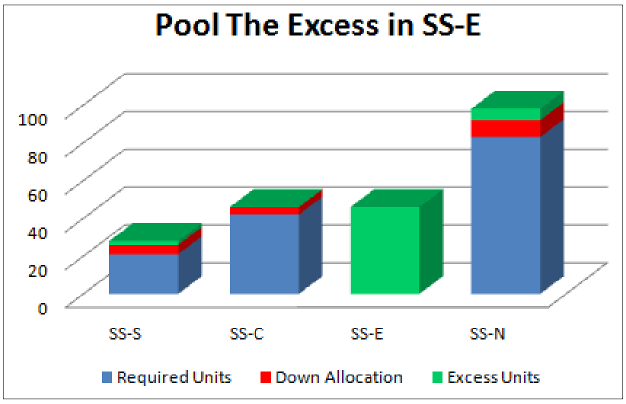

Figure 9 Excess Steam Generator Units when all the excess pooled in SS-E

6. Summary

1. Pooling the number excess units in one station gave several benefits to company. They are investment cost avoidance USD 5 Million for stopping Final Decision Investment on retrofit project, better manpower allocation, saving of disposal project cost, and better operational safety.

7. References

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