

FCCU AND DELAYED COKER SAFETY VS COST

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Cost Cutting and Safety –

Where are we going and what are the consequences

- **Modern FCCU and Delayed Cokers are becoming victims of cost cutting because they are:**
 - a. **Custom, highly engineered processes with more and more automation**
 - b. **The equipment that provides the overall function for those processes are highly customized engineered products**
 - c. **Typically the lowest cost engineering and construction company is awarded the project whether or not they have experience with the particular refinery processes**

Let's Go Through The Process – Lump Sum Bids

The E&C company has a lump sum contract from the refinery end user – so money saved on the purchase of each equipment drops to their bottom line

- E&C Project managers have a spec from the Process Licensor with approved vendors (sometimes) and considers all vendors equal as a result**
- The assumption is made – All Vendors will provide the same functionality in their equipment – that there are NO DIFFERENCES in the supplied equipment. Verification of the equipment is seldom performed except at a factory acceptance test (FAT) which is after the equipment is built**
- E&C companies have limited responsibility on the vendor selection decision process if there are deficiencies or differences in the vendors. This is because they can fall back on the Process Licensor spec**
- The E&C companies are entitled to purchase low cost – in fact, they are encouraged to do so, but definitely will not be blamed for doing so**
- But this process results in no incentive to purchase the right equipment**

The real miracle is that we have not had more refinery explosions, death, and destruction of capital infrastructure than has already occurred considering this is the criteria by which all equipment is being purchased. What should be the considerations?:

- **How the equipment is built**
- **Evaluate the attention to the details that cause catastrophic failures**
- **The ‘what if’ process – is it done by the vendor despite the specifications???**
- **Vendor Hazop – internal to the vendor – have they evaluated their own equipment fully**
- **Does the vendor even have the skill to do such evaluation**
- **The attention to the testing of the equipment – consider all problems and potentials**

We all agree that this should be the case. We believe that you all know that this is not the case in the real world.

- **The vendors approved by the process licensors often do not get verified or tested out prior to order**
- **They are never evaluated in advance to see if they can meet the spec**
- **The equipment vendor performance is typically not evaluated or validated until the factory acceptance test**
- **In some cases, the vendors are not even specified, so the E&C company has unlimited choices. This opens up a really dangerous situation for the process licensors and the end users**

Specific Example Case Of Actuator Manufacturer

- **Process Licensors seldom come to the vendor's shop to inspect how the vendor will meet their specification**
- **The Process Licensors, in some cases, rely on the fact that a vendor was inspected or evaluated 25 years ago and that the vendor at that time had a working piece of equipment in a refinery application**
- **Inspections of the equipment are made at FAT after the equipment has been built, so changes result in potential compromises**
- **Licensors are not experts in the critical equipment provided by a supplier, so they make mistakes or assumptions on how the equipment will function due to their frame of reference, years of experience and due to their interpretation of the specification they wrote**
- **The specifications are open to interpretation by the process licensor, by the E&C company and by the vendor – often with serious differences in opinion on function or compliance**

The E&C companies come to the vendor's shop to do an inspection of the facility to theoretically determine how the vendor will build the equipment

They ask for welding procedures, schedules, and listing of documents that they will need, documents that are needed whether they apply to the equipment or not

The E&C's seldom have requested proof whether in fact a vendor will meet the specification

- It is known that there are vendors who consistently do not meet the conditions of the specifications even after being a supplier for 30 years**
- This is because the Licensor potentially does not know and because they do not get data back from the installed locations. The end user has access to this data, but does not have any method readily available to communicate it back to the E&C companies or the Process Licensor**

The problem is that if a vendor were to try to educate the process licensors or the E&C companies about these deficiencies in a competitive vendor by showing:

- a. They cannot meet the required performance of the spec
- b. They do not provide this specific function or component in the spec
- c. Even if specific locations have proof of the deficiency at multiple locations
- d. Then the vendor making the factual point is accused of being a negative seller..... or worse.

Let us say there are unclear determinations of vendor status in the process licensors specifications:

- Theoretically this opens up the market to any vendor – capable or not
- The E&C companies are open then to choose the winning vendor based only upon *low prices*

- **The E&C companies go to the vendors shop to inspect according to the spec. E&C company chose the vendor.....so is there a conflict of interest? If there is no explicit vendor approved, then there is a conflict of interest and this leads to safety concerns**
- **Generally the Process Licensor does not come to the shop tests because they are not involved in the E&C companies choice of vendor. Often the Process Licensor does not find out who the vendors selected are until they come to the plant for the startup operations**
- **The Process Licensor guarantees the process, but are limited in this guarantee by low performance of the individual critical equipment that was purchased on low cost**

E&C Companies

Apples to Apples Comparison

- The E&C companies go to the effort to re-write the spec of the process licensors into their own spec. Often there are differences to the Process Licensors specification
- The E&C companies then make up check off sheets to compare all companies quoting the job to be sure they comply with the spec
- The E&C companies believe that they have apples and apples, so everything is okay
- Assumption again is that they have made the vendors equal – and this is just to prove to their stockholders that they did their due diligence and bought the low bid – no funny business on the selection process
- The vendors generally do not have an inspection in their shop. They must submit documents and test reports

E&C Companies

Apples to Apples Comparison

- The E&C companies request written compliance declarations saying that the vendor WILL meet the spec by the individual points
- Testing is done to the “vendors” test procedure. Test procedure may or may not be reviewed by the E&C company. Generally there is little or no expertise in the critical equipment component or components by the E&C company, so evaluation of test procedures or reports is suspect
- As a result, there is no verification either before or after the equipment is built and delivered that would prove actual function and performance
- This has led in the past and is still leading the future to really unsafe conditions in the industry

Examples

Let's discuss a couple of examples

- **An FCCU application – An operating FCCU and a fuse blows on a spent valve slide valve actuator electronic control system**
- **The spent valve controls the flow of carbon laden catalyst from the reactor to the regenerator**
- **If the spent valve does not operate correctly and goes open, the flow of the FCCU can be reversed and high temperature catalyst with oxygen with it can go into the reactor where hydrocarbon on the spent catalyst exist - all with high temperature conditions**
- **This actuator system equipment had been installed for 12 years and had not had any real large problems**
- **The spent valve went open with just a blown fuse**

Examples

- The actuator equipment was by specification supposed to lock in place when the fuse was blown and not let the valve go open
- The actuator vendor probably did not build the equipment correctly in the first place to meet the specifications. The E&C company probably failed to test the vendor or the equipment functions. The process licensor never has tested the company equipment so they assume that the equipment will meet the spec
- Problem is that there is no communications between the end user to the process licensor. Has the vendor changed their design?
- The vendor is still on the acceptable bidders listing of all the process licensors in the world
- Could this accident happen again – with more catastrophic results?

Examples

Example Application #2 – Blown Fuse on a FCCU Expander Turbine Inlet Valve

- The valve went wide open when the fuse blew (loss of instrument power)
- Expander turbine went to overspeed because flow to the turbine was increased
- The bypass valves started to open but could not keep flow and pressure from increasing the turbine speed
- The emergency trip function did not work and the inlet valve never got closed
- Two failures in the equipment resulted in a broken expander turbine case with turbine wheel blade parts thrown all over the city. No fire, no loss of life, and the only equipment damaged was the turbine and lube oil system

Examples

- The actuator vendor has had problems with their emergency trip functionality in four refineries with four expander turbines all going to overspeed and blowing apart
- The first one occurred 14 years ago (1997)
- What was just found was that the loss of instrument power to the electronics also caused problems and was inter-related to the emergency trip function – that did not work properly
- The expander turbine was ruined with the overall costs of millions of equipment dollars
- Lost production time with untold millions of dollars in losses
- The actuator system vendor is still on the bidders list of most if not all process licensors and E&C companies

Examples

- If the process licensor had tested the equipment to their own spec, these disasters would have been avoided
- If the E&C companies had tested properly to the spec, these disasters would have been avoided
- With no process for reviewing vendor's performance and designs, the vendor will remain on approved vendors lists

So, could this happen again with more catastrophic losses?

- In general there is a false sense of design criteria and that is for single failures – not double jeopardy
- In this case, there were two failures, unrelated in function, but resulting from related events causing catastrophic results
- Double jeopardy needs to be considered: If one failure occurs, what is the action and does that action have backup or false functionality concerns

Examples

Example Application #3 - A bad feedback device instrument on an expander turbine inlet valve actuator was being replaced during operation of the FCCU

- The technicians removed the old device by vendor procedure
- The technicians installed the new device by vendor procedure
- The technicians stroked the feedback device by itself to make sure the signals were changing and were of the correct voltage
- All functions looked good
- They put it into permanent position for operation
- They notified the control room that they were ready to go back into automatic function
- They put the actuator into service and the actuator slammed open in a half second
- Turbine went to overspeed and blew up

Examples

- The technicians' problem was that they had the slope on the signal reversed.
- They had checked that it was moving – it was – that it was of the correct voltage – it was
- But instead of correlating 1- 5 VDC close to open, they had it 1- 5 VDC open to close
- This happened, it is a simple problem, but the actuator got all the way open. Trip function was not fast enough to protect the overspeed of the turbine
- Actuator should have never gotten all the way open because the control electronics function should have locked the actuator in place with the given conditions

Examples

The expander turbine went to overspeed

- **Destroyed the turbine**
- **Caused a fire**
- **But more seriously, threw turbine parts through a pipe rack**
- **Broke several pipes in the pipe rack that then caused an even bigger fire**
- **Destroyed much equipment**
- **Shut down the refinery for an excessively long time**
- **No loss of life, but chances were very real since four guys were standing beside the inlet butterfly valve actuator when the turbine blew up.**
- **Could this accident happen again, and will the losses be more catastrophic?**

Examples

Example Application #4

Recently, a major order for equipment was awarded. The process licensor had notified the E&C company that was doing the project that they could NOT use a certain vendor as there had been troubles enough with their equipment

Results:

- The E&C company ordered the equipment from the unacceptable vendor
- This was done in contradiction to being specifically told not to in writing. Why? Because of low price
- When the process licensor found out four months later, the Process Licensor refused to guarantee the process
- The E&C company said that they had evaluated the equipment to be safe and the performance would meet the process licensors spec

Examples

Now, it comes down to who wants to go to court over this matter. Meanwhile the plant is being built, and the legal system will be slow, and the costs will be tremendous, and no one wins.

What are the main facts?

- **The end user will be receiving poor pieces of equipment**
- **The end user will end up with several potential safety hazards**
- **The process licensor will have no real power to fight the guarantee as it was 4 months after the fact that they found out the order selection and the winner of the order**
- **The E&C company has assured the end user that they will be fine – the evaluation is solid, and everything will be okay**
- **Plant personnel 4 years from now upon startup will not even know about this and they will have their lives potentially placed in jeopardy**
- **The process licensor and end user will be fighting about the fact that the guarantee of the process unit was not met because the inferior equipment does not perform as specified**

Examples

Example Application #5

In a recent industry meeting, a presentation was given that described a catalyst purchase on a heavy resid FCC Unit

- The vendor for the catalyst was selected on low price, but because the vendor was a large multi-national company, they had responsibilities to their stockholders to provide a return on their investment
- For purposes of this presentation, we will not discuss who did what and why, but the point of the issue is that the following occurred:
 - a. The catalyst vendor received the order for the initial inventory of catalyst from the E&C company with the approval in this case of the end user refinery
 - b. The end user encouraged the purchase of 3 years of catalyst to lock in the pricing of the catalyst. As you all know, the price of catalyst has gone up by a factor of 1000 over the past 3-4 years
 - c. During the startup, the Process Licensor was unable to make yield on the RFCCU

Examples

- The savings on the catalyst purchase including the 3 year spare inventory was \$250,000
- The process not making the required or predicted yield was blamed on the Process Licensors
- The difference between what the refinery could have recovered versus the actual was \$300,000,000
- Could this be avoided and could it happen again?
- Our belief is that it is happening consistently because of the processes we are following on these matters. This case was not a safety issue, but it reflects on the overall lack of communications that it is a chronic problem. The Process Licensors specified a particular catalyst, and when they arrived on site they knew that the yield of the RFCCU may not make it with the catalyst that was bought
- Purchasing personnel made a critical decision without the Process Licensors even though the Process Licensors spec was clear about what was to be purchased
- One phone call could have solved this problem – it was worth nearly 300 million dollars

Cost Comparisons

Differences in Costs:

What are the real true differences in cost of a plant if the highest bid or the best equipment for the application were purchased instead of the lowest bid. The answer is surprising, but it ranges in opinion from 6% to 10%.

- On a \$1 billion project, this will average less than \$100 million (dollars)
- This is not the real number that needs to be evaluated because not everything in a plant needs to be purchased on a high cost basis. Steel, concrete, vessels, piping, can be bought by weight/cost
- **ONLY the equipment critical to safety and process integrity** needs to be considered

So, we need to apply an evaluation of what is important

Cost Comparisons

Differences in Costs:

Of the overall equipment, there is 20% that is either critical to operation or is selected by the refinery for spare parts or refinery standards consideration

Of the 20%, only 40% of these involve process control equipment - compressors, pumps, specialty valves, specialty actuators, chemical additives, chemical control equipment and catalysts

These pieces of equipment make up a small part of the overall expenditure in a plant, and yet they are held to the same standard that buying steel, concrete, sand and gravel are held to

- **The economics are that 20% of \$100 million is \$20,000,000. 2% of Project**
- **This is the difference between high cost and low cost on the equipment in question. But 40% of that is \$8,000,000 – this is what difference needs to be evaluated. This is 0.8% of the overall project**

Cost Comparisons

- ▶ What is the cost of a shutdown on the process due to component failure?
- ▶ What is the cost of a shutdown on the process due to incorrect spec compliance?
- ▶ What is the cost of not being able to run the process at the most efficient point proposed by the process licensor?

The end user could have a plant go down simply for 1 week or 5 months due to the incorrect selection of equipment – it has happened so many times in the past 5 years

Everyone should be aware of it, but no one ever really talks about it. It is not brought up in the industry meetings such as this. Why? Because if they bring it to the attention of end users or E&C companies, it is perceived as ‘negative selling’ resulting in the loss of the vendors’ reputation who has fallen victim to poor purchasing decisions.

Cost Comparisons

- Multiple plants have either not started up on time or have had problems during startup
- Multiple plants have been totally shutdown just in the past 3 years with more than 1 month total time due to inferior purchased equipment – costing well over \$50 - \$180 million in each case
- The savings on these particular individual pieces of equipment that caused these catastrophic amounts of money was a maximum of \$80,000 and as little as \$5,000
- 1-2 years spent in startup mode instead of being in full operation
- 1 - 5 months of failed operation

How many Millions of Dollars In Costs Is This?



Safety Comparisons

Safety

- If you are shutting down a plant for inferior equipment operation, is this also a safety concern?
- Can safety be evaluated on money spent and/or what is a life worth? It is done all the time – just make sure when you are making these dollar decisions that you avoid the evaluation of your own life

We want to challenge you to think about what we are doing in this industry where, overall, we have had exceptional safety records and minimal loss of life. Are we lucky?

Should luck be a factor?

Solutions

- **Licensors should be intimately involved with the purchase stage and should have approval over any purchase of critical equipment**
- **Licensors should be inspecting vendors with the purpose of regularly evaluating the vendors capabilities to actually meet the intention of the spec**
- **Licensors should remove vendors who do not comply, but have a process for re-instatement when deficiencies are proven to be solved**
- **Licensors should be using vendors to advise in the spec on the hazardous operations evaluations**
- **Licensors should keep records of problems in the field and work with the vendors to solve inherent problems**
- **Licensors should inform the other vendors as to the problems they have encountered in the field (not disclosing individual vendors) and make sure all vendors do not have such problems in future**

Solutions

Engineering and Construction Companies Responsibilities:

- Critical equipment should NOT be evaluated only for low price and delivery time
- Critical equipment should be proven in each aspect of the spec and INTER-RELATED aspects of the spec for how they will perform the functions of the spec
- Double jeopardy must apply on the related functions in the spec – evaluation must be performed
- All critical equipment should have the approval of the licensor at time of purchase
- All critical equipment should have the approval of the end user at time of purchase

Solutions

Engineering and Construction Companies Responsibilities continued:

- All critical equipment must be inspected at a factory acceptance test with the E&C representative and the end user company representative
- All factory acceptance tests procedures must be reviewed by E&C company and by process licensors
- Field acceptance testing must be completed with all aspects of the equipment fully tested for critical operations

Higher reliability and safety in equipment is available without compromise! It may come at a higher purchase cost but is worth the investment in production savings and human safety.