

FCCU AND DELAYED COKER SAFETY VS. COST

Neal E. Cammy, BLAC INC. Engineering Manager
neal.cammy@blacinc.com



Overview

- ▣ **Problems With Low Cost Supply**
- ▣ **Examples**
- ▣ **Capital Project Cost Comparisons**
- ▣ **Solutions**



blac inc.

BLACK LIMITED ADVANCED CONTROLS



USFCG
Extended Run Flow Control®

Planning a Traditional Wedding



blac inc.

BLACK LIMITED ADVANCED CONTROLS



USFCG
Extended Run Flow Control®

Planning a Traditional Wedding



- ❑ **Bride usually issues the specifications**
 - Wedding location
 - Food, Music, Flowers
 - Dress
 - Ceremony, etc.
- ❑ **Father is paying, so he hires Wedding Planner – the “Procurement Manager”**
- ❑ **But Wedding Planner never talks to bride and groom**



blac inc.

BLACK LIMITED ADVANCED CONTROLS



USFCG
Extended Run Flow Control®

Planning a Traditional Wedding

- ❑ Procurement Manager follows all the specs exactly
- ❑ Procurement Manager satisfies his client (Father)
 - Meets the spec at the lowest cost
- ❑ Father is happy!

Will the bride be happy?



blac inc.

BLACK LIMITED ADVANCED CONTROLS



USFCG
Extended Run Flow Control®

Cost Cutting and Safety-

Where are we going and what are the consequences?

- ▣ FCCU and Delayed Cokers victims of cost cutting
- ▣ Custom, highly engineered processes
- ▣ More and more complex automation required
 - ▣ Custom engineered products
- Project awarded to lowest cost engineering and construction (E&C) company
 - Irrespective of experience (lack of) with the particular refinery processes



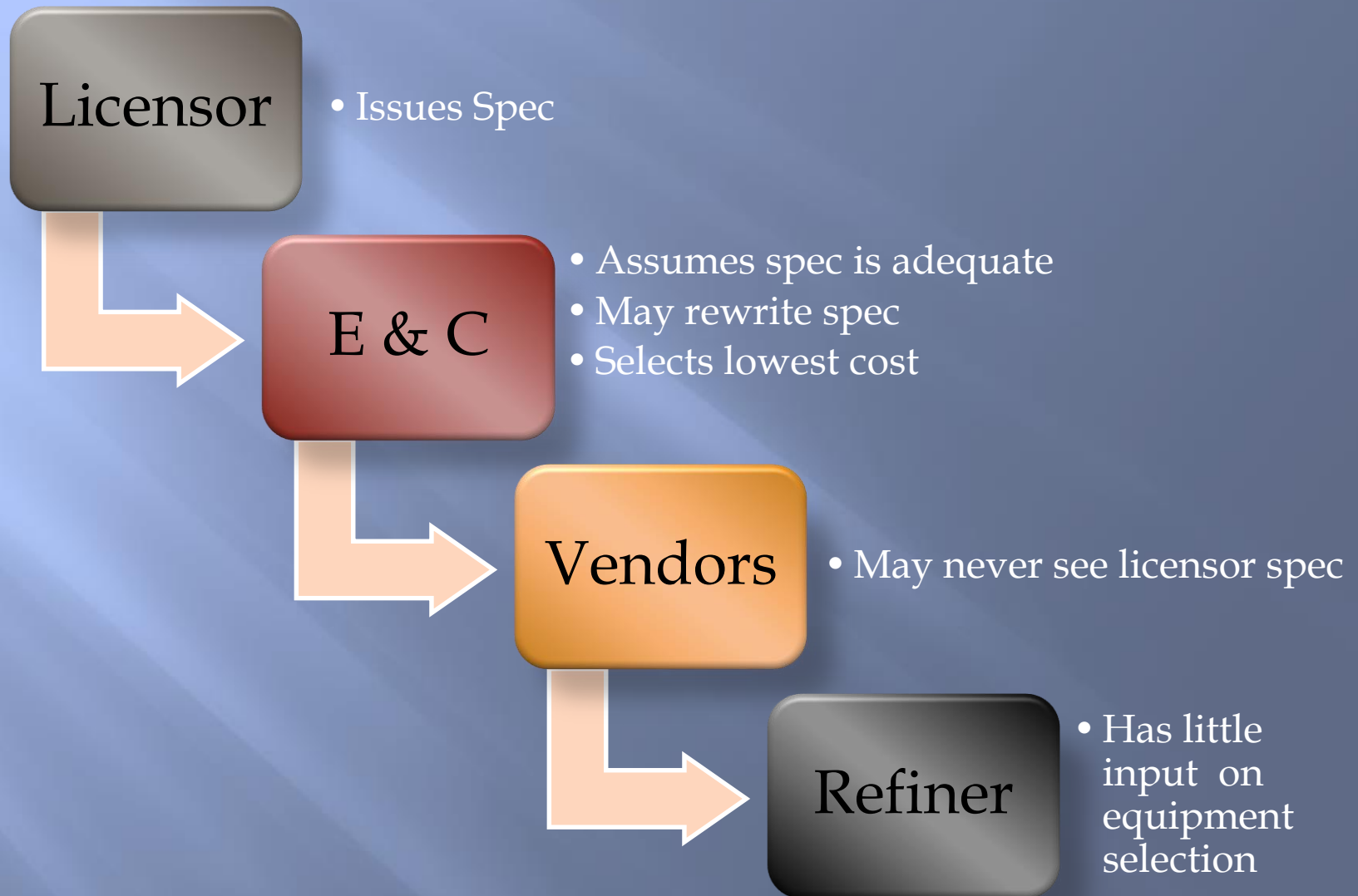
blac inc.

BLACK LIMITED ADVANCED CONTROLS



USFCG
Extended Run Flow Control®

Supplier Selection Process



blac inc.

BLACK LIMITED ADVANCED CONTROLS



USFCG
Extended Run Flow Control®



E & C Lump Sum Contracts

- **Encouraged to purchase low cost**
 - No incentive to choose better equipment
- **E&C project managers have spec from process licensor with approved vendors (sometimes)**
- **Assumption that ALL Vendors qualified by licensor will provide the same functionality**
 - Assume NO DIFFERENCES in the supplied equipment.
 - No need to spend time evaluating performance of vendor's equipment
- **E&C limits their responsibility for vendor selection**
 - Fall back on licensor spec



blac inc.

BLACK LIMITED ADVANCED CONTROLS



USFCG
Extended Run Flow Control®

Principle of Equipment Supply



blac inc.

BLACK LIMITED ADVANCED CONTROLS



USFCG
Extended Run Flow Control®

Selection Considerations

- ▣ **How is the equipment built?**
- ▣ **What details can cause catastrophic failures?**
 - ▣ Is this review done by the E&C and vendors to the specifications???
- ▣ **Vendor PHA – internal to the vendor**
 - ▣ Have they evaluated their own equipment fully?
 - ▣ Does the vendor even have the skill to do such evaluation?
- ▣ **Equipment testing**
 - ▣ Does it consider all problems and potential failures



blac inc.

BLACK LIMITED ADVANCED CONTROLS



USFCG
Extended Run Flow Control®

Selection Considerations

- ❑ Licensor approved vendors' rarely (if ever) evaluated in advance to see if they can meet the spec
- ❑ Equipment vendor performance typically not validated until the factory acceptance test
- ❑ In some cases, the vendor *not* specified by licensor or end-user
 - ❑ E&C company has totally free choice
 - ❑ Potentially dangerous situation for the process licensors and the end users



blac inc.

BLACK LIMITED ADVANCED CONTROLS



USFCG
Extended Run Flow Control®

Specific Case: Actuator Manufacturer

- ▣ **Process licensors seldom come to the vendor's shop**
 - Some rely on the fact that a vendor evaluated 25 years ago
- ▣ **Licensors are not experts in supplier's equipment**
 - They make mistakes or assumptions on the equipment function
 - Based on frame of reference, experience and interpretation of the spec they wrote
- ▣ **The specifications are open to interpretation by process licensor, E&C company, and vendor**
 - Often with serious differences in opinion on function or compliance



blac inc.

BLACK LIMITED ADVANCED CONTROLS



USFCG
Extended Run Flow Control®

Licensors Verification

- **Process licensor not involved in E&C choice of vendor**
 - Does not normally come to shop test
 - Often the process licensor does not find out who the vendors selected are until they come to the plant for startup operations
- **The process licensor guarantees the process**
 - Process may be limited by low performance of equipment that was purchased on low cost
 - Licensor (and equipment vendor) reputation at stake if critical equipment performs poorly



blac inc.

BLACK LIMITED ADVANCED CONTROLS



USFCG
Extended Run Flow Control®

E&C Vendor Selection

- ❑ **Often re-write the spec of the process licensor**
 - Often differences with licensor spec
- ❑ **Prepares check off sheets to compare all vendors for spec compliance**
- ❑ **Assumption is that the vendors are equal**
 - To prove to their stakeholders 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**
 - Submit documents and test reports and compliance declarations



blac inc.

BLACK LIMITED ADVANCED CONTROLS



USFCG
Extended Run Flow Control®

E&C Vendor Selection

- ▣ Testing is done to the *vendor's* test procedure
- ▣ Test procedure may or may not be reviewed by the E&C company
 - Generally there is little expertise in the critical equipment component by the E&C company
 - Evaluation of test procedures or reports is suspect
- ▣ As a result, no verification before or after the equipment is delivered that would prove actual function and performance
- ▣ This has led in the past and is still leading the future to potentially unsafe conditions in the industry



blac inc.

BLACK LIMITED ADVANCED CONTROLS



USFCG
Extended Run Flow Control®

FCC Power Recovery Expander Inlet Valve Failure

- ❑ The valve went full open when the fuse blew (loss of instrument power)
- ❑ Expander turbine speed increased above maximum allowed, due to increased gas flow
 - Regenerator pressure dropped
- ❑ The emergency trip function failed
 - Valve never closed
- ❑ Two failures in the equipment resulted in:
 - Broken expander casing 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



blac inc.

BLACK LIMITED ADVANCED CONTROLS



USFCG
Extended Run Flow Control®

FCC Power Recovery Expander Inlet Valve Failure

- ▣ **Actuator vendor had problems with emergency trip function in four refineries**
 - All four power recovery expander turbines all going to overspeed
 - The first one occurred in 1997
- ▣ **Loss of instrument power to the electronics also caused problems and was related with the ESD trip function**
 - ESD also did not work properly
- ▣ **Failure costs:**
 - The expander turbine casing and rotor was ruined with the overall costs of millions of equipment dollars
 - Lost production time with millions of dollars in losses
- ▣ **The actuator system vendor is still on the bidders list of process licensors and E&C companies**



blac inc.

BLACK LIMITED ADVANCED CONTROLS



USFCG
Extended Run Flow Control®

FCC Power Recovery Expander Inlet Valve Failure

- ▣ 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



blac inc.

BLACK LIMITED ADVANCED CONTROLS



USFCG
Extended Run Flow Control®

Could this happen again with more catastrophic losses?

- ▣ Traditionally, equipment design considered single failures – not multiple failures
- ▣ In this case, there were two failures, unrelated in function, but resulting from related events to cause catastrophic results
- ▣ Multiple failures need to be considered:
 - If one failure occurs, what is the action?
 - Does that action have backup or false functionality concerns?

Cost Comparisons

Differences in Costs:

What is the true difference in plant cost if the best equipment for the application were purchased?

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**
- ▣ **Not everything 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**



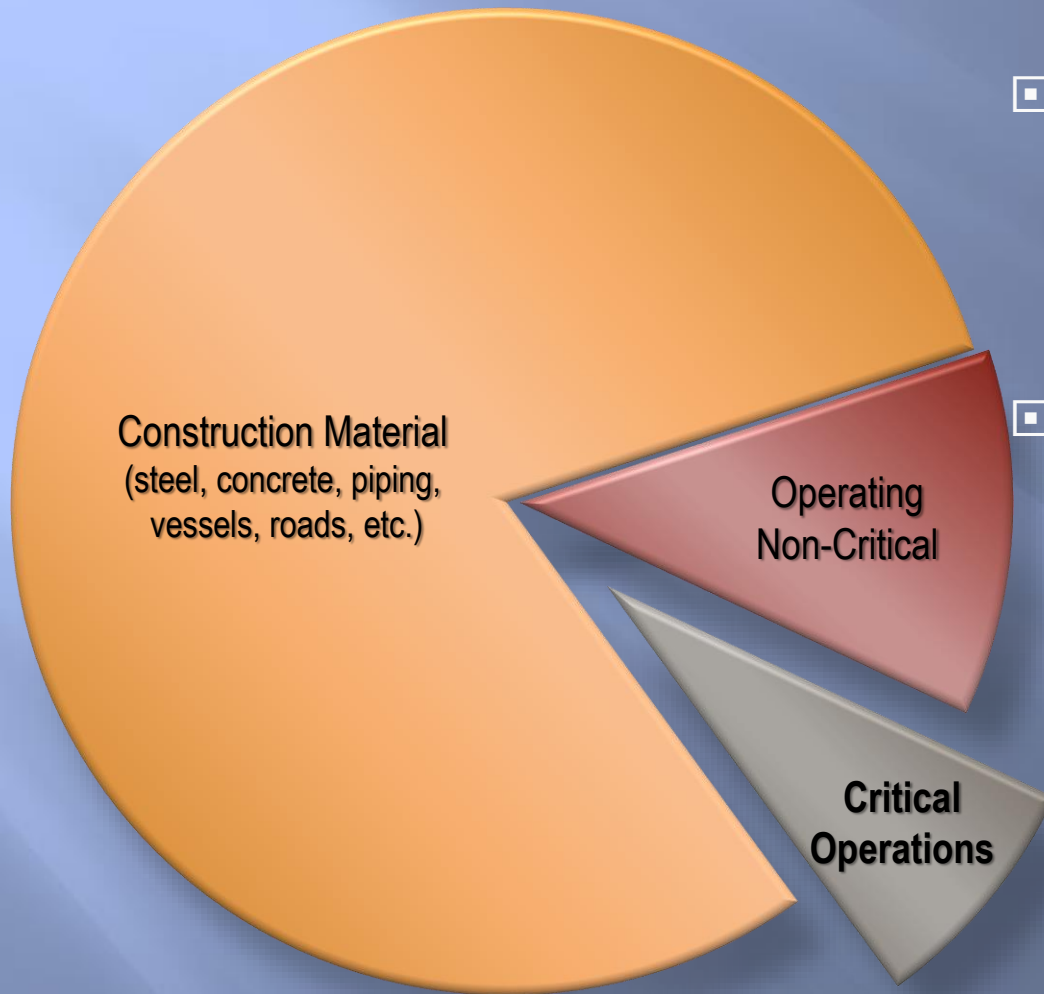
blac inc.

BLACK LIMITED ADVANCED CONTROLS



USFCG
Extended Run Flow Control®

Project Costs



- ▣ 20% is operating equipment
 - Special consideration by plant owner
- ▣ 40% of operating equipment is critical
 - Compressors, pumps, instruments, valves, actuators, catalyst, additives, etc.

Should we purchase the operations critical equipment using the same standards as concrete, steel and gravel?

Critical Operations Equipment For \$1 billion Project

- ▣ **6%-10% is Max Difference in Cost of Plant**
 - \$100 million

- ▣ **20% of Total is Operating Equipment**
 - \$20 million

- ▣ **40% is Critical to Operations Equipment**
 - \$8 million of overall project - 0.8%

Real Costs

- ▣ **What is the cost of:**
 - A shutdown on the process due to component failure?
 - A shutdown on the process due to incorrect spec compliance?
 - Not being able to run the process at the most efficient point proposed by the process licensor?
 - A delay in the startup of the plant after construction?

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



blac inc.

BLACK LIMITED ADVANCED CONTROLS



USFCG
Extended Run Flow Control®

Real Costs

- ❑ Many units have had delays or problems during startup
- ❑ In the past 5 years, multiple units have been shutdown
 - >1 month total down time due to inferior purchased equipment
 - \$25 - \$180 million losses in each case
- ❑ The savings individual equipment 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



blac inc.

BLACK LIMITED ADVANCED CONTROLS

Safety

- ❑ **If you are shutting down a plant due to inferior equipment operation, is this also a safety concern?**
 - Incidents more likely to happen during startup/shutdown
- ❑ **PHA techniques may not account for differences between performance of Vendor A and Vendor B's specialty equipment**
 - Did you increase the probability of failure because the contractor bought low cost equipment?

We want to challenge you to think about what we are doing in this industry that has had an exceptional safety record and minimal loss of life. Are we lucky?



blac inc.

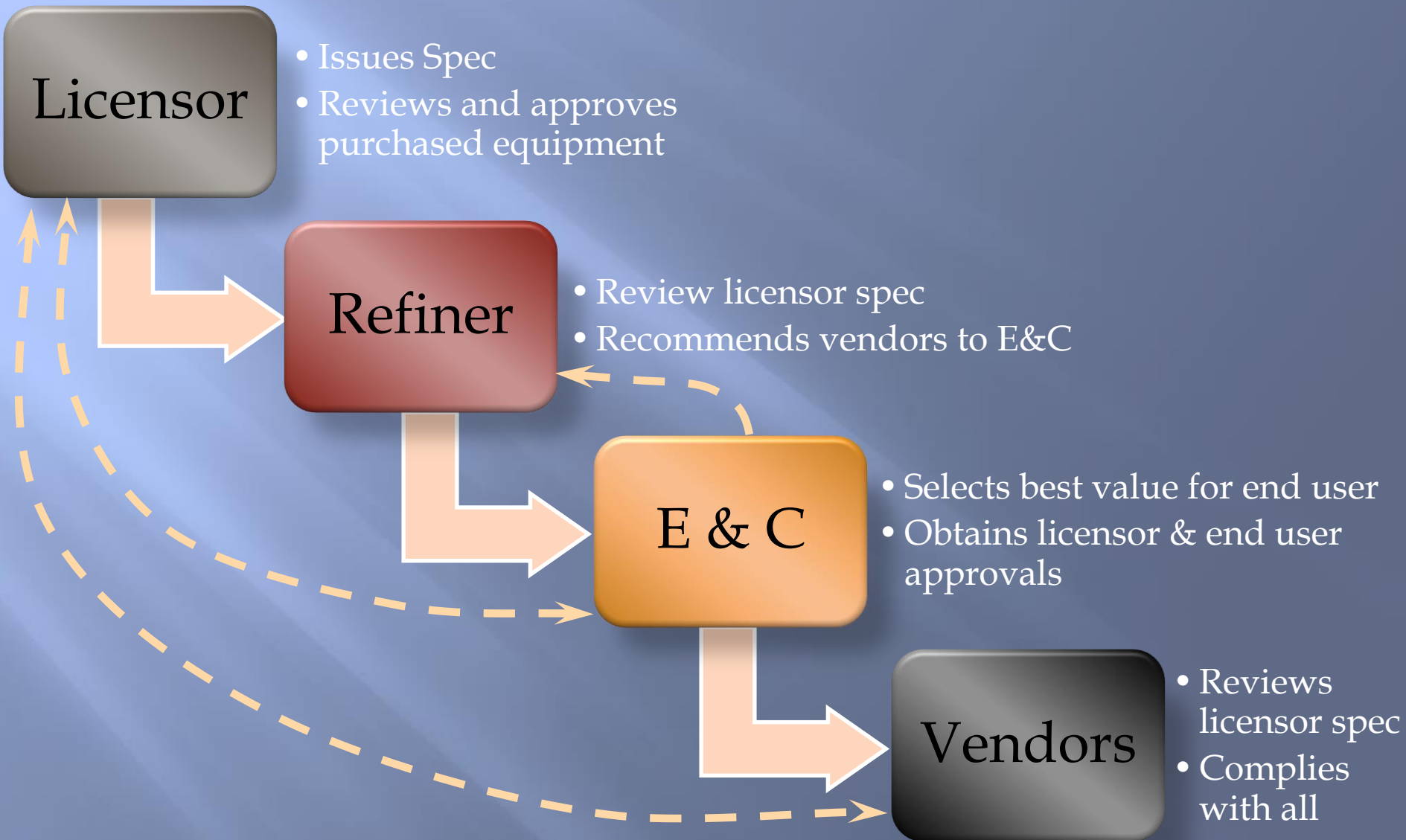
BLACK LIMITED ADVANCED CONTROLS

Should luck be a factor?



USFCG
Extended Run Flow Control®

Ideal Vendor Selection Process



Solutions—Licensors

- ▣ **Intimately involved with the purchase phase**
 - Should have approval over any purchase of critical equipment
- ▣ **Evaluate vendors regularly for capabilities & compliance to spec**
 - Verify actual performance of equipment
- ▣ **Remove vendors who do not comply**
 - Have a process for re-instatement when deficiencies are proven to be solved
- ▣ **Use vendor's personnel for advice during PHA's**
- ▣ **Keep records of problems in the field and work with the vendors to solve inherent problems**
 - Some, of course, do this now
- ▣ **Share field problems with all vendors (without disclosing individual vendors)**
 - Ensures that all vendors prevent reoccurrences of problems



blac inc.

BLACK LIMITED ADVANCED CONTROLS



USFCG
Extended Run Flow Control®

Solutions—End Users

- **Plant personnel should take active role in critical equipment selection**
 - Lump Sum projects can separate end user from purchasing
 - Plant personnel change over life of project
- **Safety, reliability and long term operability should take precedent over initial capital cost**
 - Total cost of ownership (TCO) should apply
 - Difficult to do with today's "short term" view
 - Evaluate refinery "standards" for applicability to each type of equipment
 - Non-process utility equipment (e.g. electro-hydraulic actuator systems) may not need to follow some specs intended for process equipment



blac inc.

BLACK LIMITED ADVANCED CONTROLS



USFCG
Extended Run Flow Control®

Solutions—Vendors

- ▣ **Reviews licensor's spec regularly**
 - Suggests equipment changes/improvements to licensor
 - Discusses potential specification improvements to licensor (and E&C companies)
 - ▣ To facilitate purchase and avoid costly confusion



blac inc.

BLACK LIMITED ADVANCED CONTROLS



USFCG
Extended Run Flow Control®

Solutions—E & C

▣ Critical equipment:

- ▣ Should NOT be evaluated only for low price and delivery time
- ▣ Have proof of functional performance for each aspect and interrelated aspects of the spec
- ▣ Multiple failures must apply on the related functions in the spec
 - Evaluation must be performed
- ▣ Should have the approval of the licensor at time of purchase
- ▣ Should have the approval of the end user at time of purchase



blac inc.

BLACK LIMITED ADVANCED CONTROLS



USFCG
Extended Run Flow Control®

Solutions—E & C

- ▣ **All critical equipment must be inspected at a factory acceptance test (FAT)**
 - E&C representative
 - End user company representative
 - Licensor representative optional (at discretion of licensor and End User)
- ▣ **All FAT procedures must be reviewed by E&C and by process licensor**
- ▣ **Site acceptance testing (SAT) 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 it is worth the investment in production savings and human safety.



blac inc.

BLACK LIMITED ADVANCED CONTROLS



USFCG
Extended Run Flow Control®