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Instrumentation Adequacy Check for the Debottlenecking Projects and the Impact on Process Safety

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Abstract

The debottlenecking projects are always challenging since there is a tradeoff between the costs of the project and achieving the new production rate of the plant i.e. achieving the new production rate with optimized cost to make the project feasible. One important step at the beginning of the basic engineering phase of the debottlenecking project is to do adequacy check for the existing instrumentation for the new process conditions of the revamp. If one can imagine a leak from a thermowell for a toxic material, a failure of undersize actuator, not-properly ranged transmitters or valve internal damage for not suitable material, it will be obvious how process safety come to the picture here. Because of un-proper engineering review and overlooked adequacy aspects checks, this may lead to the process safety concern that we are trying to avoid in the plant after debottlenecking took place. In this paper, a proper adequacy engineering check for instrumentation will be discussed from process safety point of view.

1. Understanding the need, the impact and the constraints

Obviously re-using the existing instruments can save money however, it requires considerable efforts and thorough assessment. It is important for the debottlenecking/revamp project management team to decide the strategy for the instrumentation and controls revamp. There are some factors affect the decision making process, examples are below:

1. The age and history of the plant: the age of the plant and the previous failures, incidents and history of the plant should be studied. Risk related and repeated failures items that may have an impact on the decision should be carefully reviewed.
2. Space available: space available is a limiting factor in many cases; example is the available room in the control building to expand the control systems, analyzer room or shelter.

3. Some Equipment are to be replaced based on Equipment debottlenecking decision, on such cases a strategy is required to be decided whether to go for replacement or should undergo adequacy check.
4. Data availability: The availability of the plant design data and as built documents/drawings are very important for revamp project. Not only this, it is also important that the native files are available for easy editing. Another related problem is that whether the files are up to date or not, if they are not, is it required to update them?
5. Obsolescence: it is required to check if the control systems are already obsolete, and what is the requirement of upgrades? Is it possible to integrate new systems with the existing legacy system? This is applicable also for instrumentation.
6. Vendor availability: it is also important to check if vendor are available for required support. This is also applicable to the packaged equipment.
7. International Standards: up what extent will the revamp/debottlecking projects comply with the international standards? This is should be documented on the design basis or design criteria for the project and agreed upon between all parties.

The impact of bad adequacy check is related of course to the consequences and the likelihood for the specific failure scenario under discussion , but the failure which are related to design issues and flaws may have direct impact on process safety , below are only examples for such cases :

1) Control valves:

    a. Capacity: if the valve has less/more capacity than it is required in revamp case, it may lead to safety concern in cases like cooling/heating service, dry run, minimum flow…etc.
    b. Actuator failure: if undersize, it may lead to leakage from bonnet or packing or completed failure, which may lead to loss of containment.
    c. Cavitation or flashing: valves may have cavitation or flashing in revamp case and if it is ignored, this is may lead to internals damage or could lead to pin hall in the valve body and consequently leakage of the process fluid.
    d. Velocity: high velocity at the outlet of the valves, if not managed, it will create damage to valve internals and downstream structure.
    e. Noise: beside its harmful nature to the personal safety, it is having a destruction effect for the valves in certain cases, so it is important to be managed carefully.

2) Flow meters :

    a. It should be noted that the adequacy for the flow elements should not rely only on the hydraulics check of the system since this is mainly a check of the permanent pressure drop across the element.
    b. Transmitter range and rangability check is required; revamp criteria should be defined clearly and documented.
    c. If the ranges are not set correctly , it will affect the flow controls

3) Thermowell: a leakage of toxic or flammable material may lead to safety concern, this is in case velocity or flow rate changes on the pipeline, which may increase the stresses in the thermowell and lead to failure or small leakage.

4) Analyzers Sample System: Careful check for the sample system components for pressure, temperature, material is required, since human interface with this system is higher than other system and it could lead to personal safety.

5) Alarm and Trip set points: Since some of the alarms are considered as independent layer of protection, it is very important to review the alarm and trip set points completely.

6) PSV: relieve capacity and set point of the PSV's have a direct impact on process safety.

2. Process Safety and the Adequacy Check

Seeing the impact in process safety in section-1 of the failure of doing the right checks or overlooking certain important system or process parameter in the process of the adequacy checks, a clear approach is required to manage the risks and help support the project management team to take the right decision at early stages of the project and share the findings and the decision with all stakeholders of the project.

A suggested approach in Section 3 is developed to make a clear road map for the engineers, project engineers, project management and stakeholders to perform the adequacy check for the debottlenecking projects.

3. Road Map to proper Adequacy Check for Debottlenecking Projects

This approach (Fig. 1) is based on checking the requirements of the adequacy check process at early stage of project, probably even before the start of the project, below are the steps explanation:

Step-1: Identify the process unit area which require Adequacy Check

This is a very important step; the output of this step is a clear scope of work for the adequacy check work. It is recommended to conduct review meeting with all discipline engineers including process safety to check the Piping and Instrumentation Drawings and limit the scope of the adequacy check to the affected area ONLY.

Step-2: Data Collection

Once agreed on the affected process unit areas, the data collection step is started and should identify all affected tag numbers and collect the required data for adequacy i.e. data sheets, calculation sheet, vendor drawings, Hook-up drawings, history records and management of change records…etc. It is crucial to examine the As-built drawings status and confirm that they

are up to date. Current systems configurations and ranges print-out is also required to be collected. Current systems alarm and trip set points are required to be collected as well.

Step-3: Identify the required Vendors Support

Sometimes it is required certain vendor support for some special sizing or some information which is not available in the current plant data. List all the required support from vendor , confirm the availability of vendor and start communication with the vendor to confirm that the required support can be conducted by him , it is better to get cost estimate for each support required from each vendor.

Step-4: Identify the required Resources

Good estimation of the man-hours and man power required should be available since the volume of work is identified in Step 1-2. In addition to that, the in-house software/hardware required to conduct the adequacy check should be identified with cost estimate.

Step-5: Assessment

The team should decide now if the available data, vendor support and the required resources are good enough to proceed further and conduct the adequacy check. Part of the assessment can be benefit-cost analysis, which will compare replacement vs. re-using the existing assets. It can support the decision to go or not to go with the adequacy check.

Step-6: Define the adequacy criteria and the acceptable limits.

In this step document shall be developed for defining the adequacy criteria for the instrumentation, example: control valve opening percentage, actuator, noise …etc., the same thing for other instrumentation. The acceptable limits for each criteria shall be also defined. It is recommended that the project team management and stakeholders are to approve this document. Since it is the basis for the adequacy check work this step considered critical.

Step-7: Develop process data sheet for each instrument tag number

To make the work flow clear from Process to Instrumentation group, it is highly recommended to develop process data sheet for each instrument tag which shows the new process conditions after revamp. Good data in this will make the decision easier at later stage.

Step-8: Perform Adequacy Check

Calculation sheets should be generated out of this step, which indicate the new values after revamp of the criteria selected.

Step-9: Pass / Fail, Adequate / Not Adequate

Report should be generated in this step including all instruments, which undergo adequacy check it should be clearly concluded for every instrument whether it is Adequate or not Adequate per criteria.

Replacement Strategy

If replacement strategy is decided, it should be documented how is the replacement will be done is it a complete replacement? Or only some parts like actuator, orifice,…etc. What about the replaced equipment?

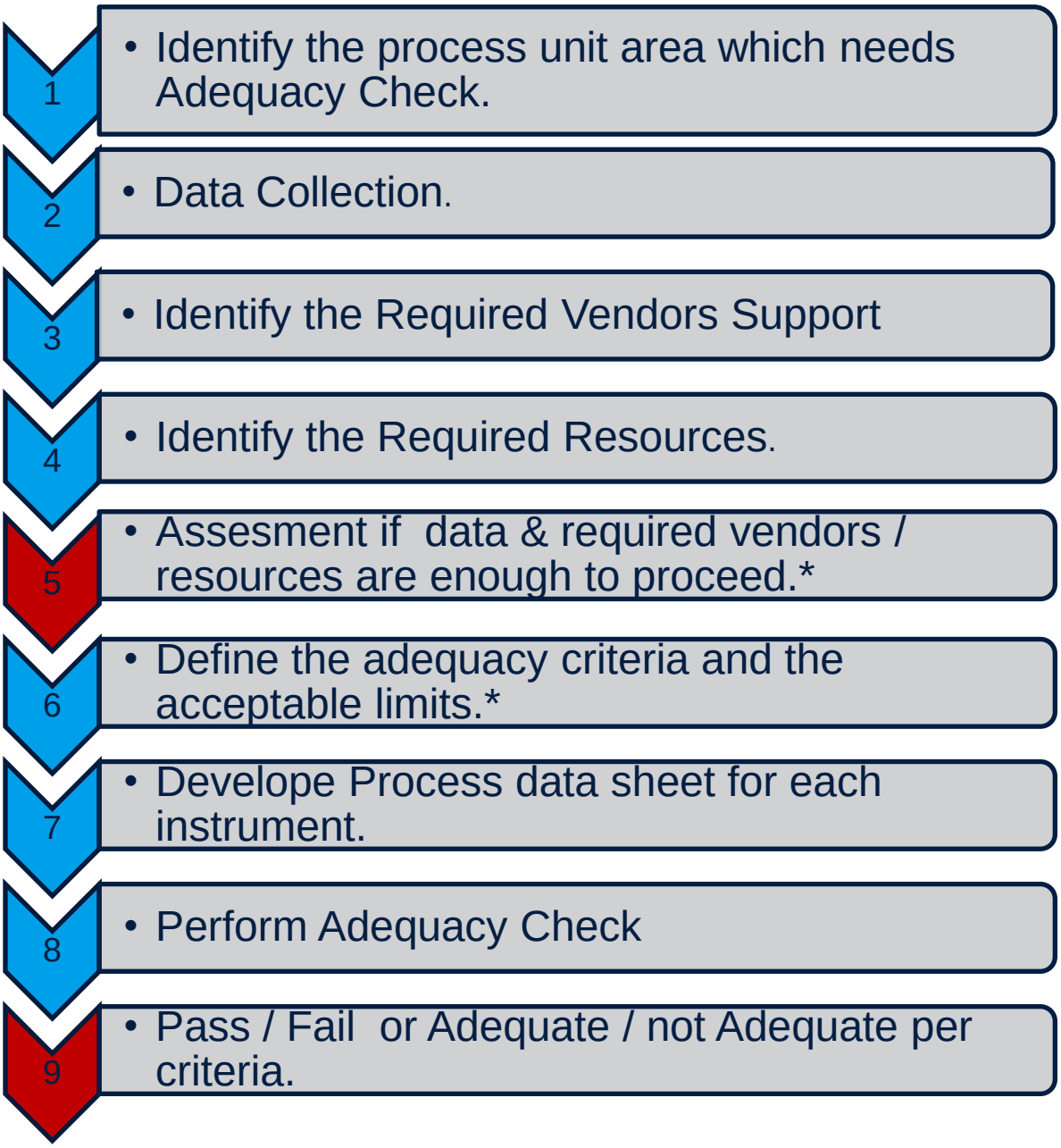

Fig.1

*Required Approval from Project Management Team and Stakeholders.

5 & 9: If NO, refer to Replacement Strategy.

4. Conclusion

Road map is presented in this paper to have systematic approach for conducting the adequacy check for the revamp and debottlenecking projects.

5. References

Avoid Instrument Issues During Revamps , Girish Sathyanarayana, KBR Hydrocarbons , 2011 , Chemical Processing