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PLAN FOR THE "WHAT-IFS" – A TUBULAR EXAMPLE

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INTRODUCTION

Anyone who has experience in planning or working turnarounds understands that, as a rule of thumb, the cost of any given task tends to increase by about five times when compared to routine maintenance and inspection. This can be attributed to numerous factors, including increased labor rates and overtime, increased demand for tools and equipment, bottlenecks due to delays for various reasons, turnaround scope creep, and lost opportunity costs of production.

Furthermore, turnarounds require a tremendous amount of planning and coordination, the lack of which can lead to costly delays and frustration for those involved. This planning should take into consideration all of the "what-ifs" that may arise during the project, as well as the proper course of action to take if and when a "what-if" does occur. Each of these "what-ifs" require a decision to be made, decisions take time and time equates to money.

This article describes the application of decision trees (also referred to as workflows) to help inspectors and technicians make decisions related to common turnaround processes. Decision trees are graphical representations of conditions, tasks, and outcomes that can be applied to nearly any closed loop mechanical integrity or inspection workflow process. They can be used to spell out the tasks involved in a process, or to connect multiple processes together in a logical manner.

As a practical example of the concept and application of decision trees, this article focuses on how decision trees can be applied to heat exchanger tubular inspection. However, one should consider the numerous other activities that can be made more efficient and streamlined by using decision trees. For example:

- Holistic mechanical integrity implementation processes
- Inspection, testing, and preventive maintenance workflows
- Turnaround inspection planning workflows
- Engineering similar service studies and damage mechanism assessments
- Higher-level process safety management processes

DECISION TREES AND HEAT EXCHANGER TUBULAR INSPECTION

Heat exchanger tubular inspection is one of the most expensive and time consuming activities that takes place during turnarounds or outages. Tubular inspection requires multiple maintenance craft activities, including the disassembly, cleaning, inspection, re-installation, and repair of exchangers; all of which can be very time consuming. So, finding ways to optimize or make the process more efficient might pay huge dividends in the form of time and cost savings. This is a prime (yet rarely identified) situation where decision trees can have a positive effect on a turnaround's bottom line.

Developing and applying decision trees can help to streamline the entire heat exchanger tubular inspection process by reducing the amount of time spent making decisions. For example, decision trees can replace the need for daily or per shift repair recommendation meetings and expedite the work steps required for exchanger maintenance and testing. In doing so, the majority of the decisions that need to be made during a turnaround or outage scenario can be planned, agreed upon, and entered into the scope of work prior to the event. When a situation that is addressed in a decision tree arises, the predetermined steps can be followed immediately, thus, eliminating the time normally lost to waiting for and making decisions.

When planning tubular inspection activities, there are many processes to take into consideration. As such, multiple decision trees can be developed for each of these processes. Take for example one area that commonly presents major tubular inspection problems or issues—tube cleanliness. Tube cleanliness directly impacts the effectiveness and accuracy of any tube inspection and can vastly affect the outcome and quality of the inspection. There are many different tube cleaning methods as well as various levels of cleanliness needed for the different tube inspection methods. Information gathered from engineering process data and process safety management (PSM) documentation should be used to better understand which cleaning technique should be used. This information, when applied to a decision tree and prior to any field activities, can significantly reduce time and cost due to the need for re-cleaning tubes to gain the level of cleanliness needed.

Figure 1 illustrates such a decision tree. Starting at the top of the workflow and following the arrows, the inspector must first determine which testing method will be applied for a given tubular inspection. In this example, the inspector must choose between the IRIS and Eddy Current Testing techniques based on factors such as which damage mechanisms are being targeted and costs associated with the test methods. Note that the number of potential techniques is limited to only those which are applicable to this situation. The inspector doesn't have to spend vital cognitive effort considering other techniques; the decision-making process is simplified.

After choosing the appropriate test method, additional branching arrows guide the inspector through a series of tasks and "what-ifs" that ensure that the inspection is performed appropriately.

Another example of where a decision tree can make a significant

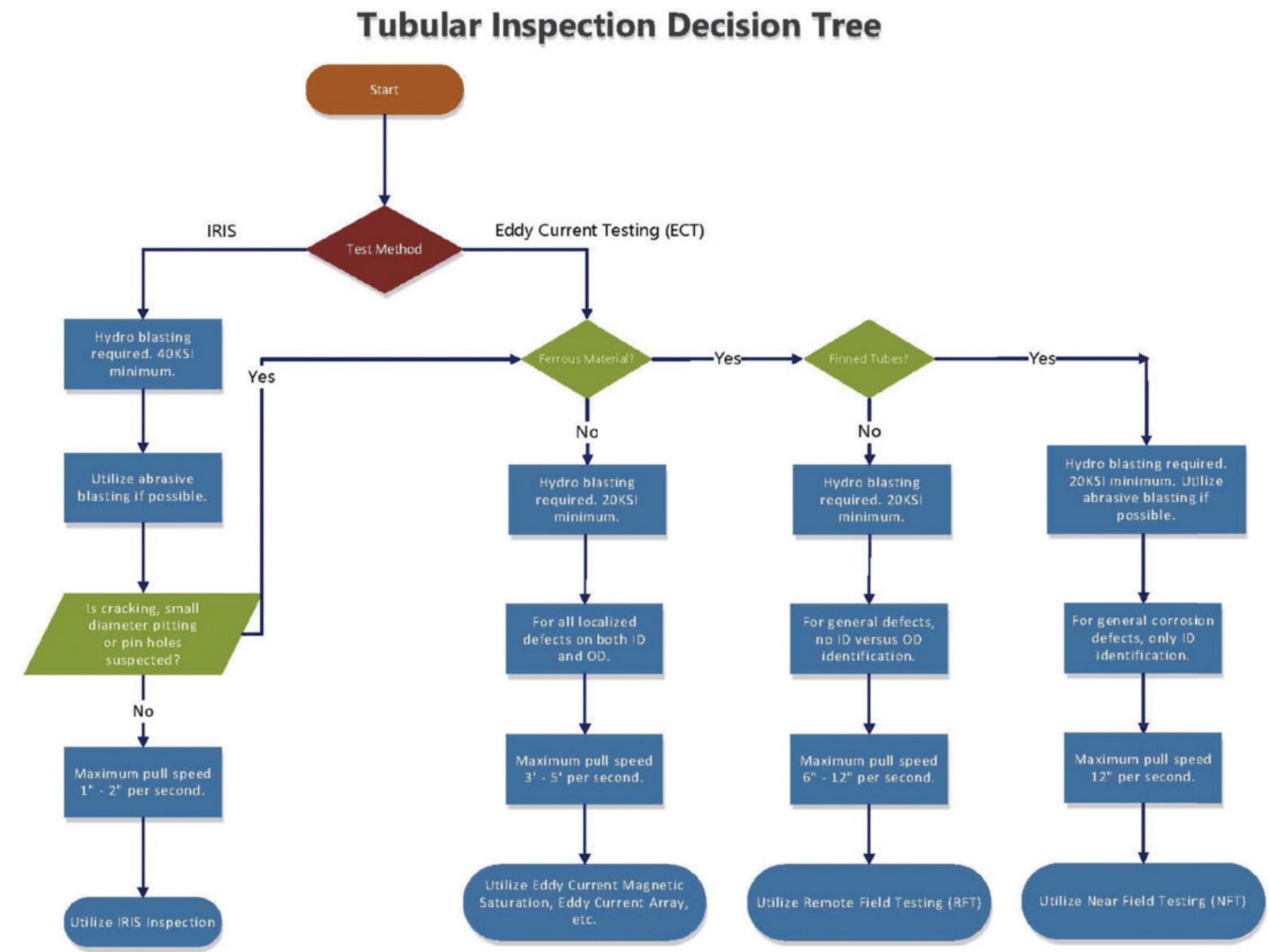

Figure 1. Tubular Inspection Methodologies and Cleaning Techniques Decision Tree

positive impact is a workflow to determine the percentage of tubes that need to be inspected, as well as a tube inspection pattern that will encompass enough information to determine the levels of degradation that the exchanger has experienced. This workflow will also include engineering process data as well as PSM documentation to determine the criticality of a possible emission experienced by a tube leak. Depending on the criticality, efficiency, and overall design of the exchanger, one may only need to inspect a low percentage of the total tubes in the exchanger to acquire the information needed.

Once the Inspection Test Plans have been created for the different tube inspections to be carried out and the tube inspection crews are deployed to the field, there are many ways that inspection activity workflows can be of value. For example, when an inspection is in progress and data is being collected, a tube inspection analyst will be reviewing the results as the field crew is collecting the data. When a tube inspection analyst is utilizing a workflow based on the analysis results of the inspection, it will be known —in real time—if the inspection scope needs to be increased or if the inspection needs to be terminated due to high levels of degradation and move on to the next inspection. This can save a significant amount of time and cost, as the analyst no longer has to complete the analysis, create a written report, submit the report to the turnaround team for further analysis and decision on increasing the inspection scope, plugging tubes, retubing an exchanger, etc. If the tube inspection analyst has a predetermined workflow, the tube inspection crew can work more efficiently and effectively with the time allotted for the inspection activities, which results in reduced inspection time and cost.

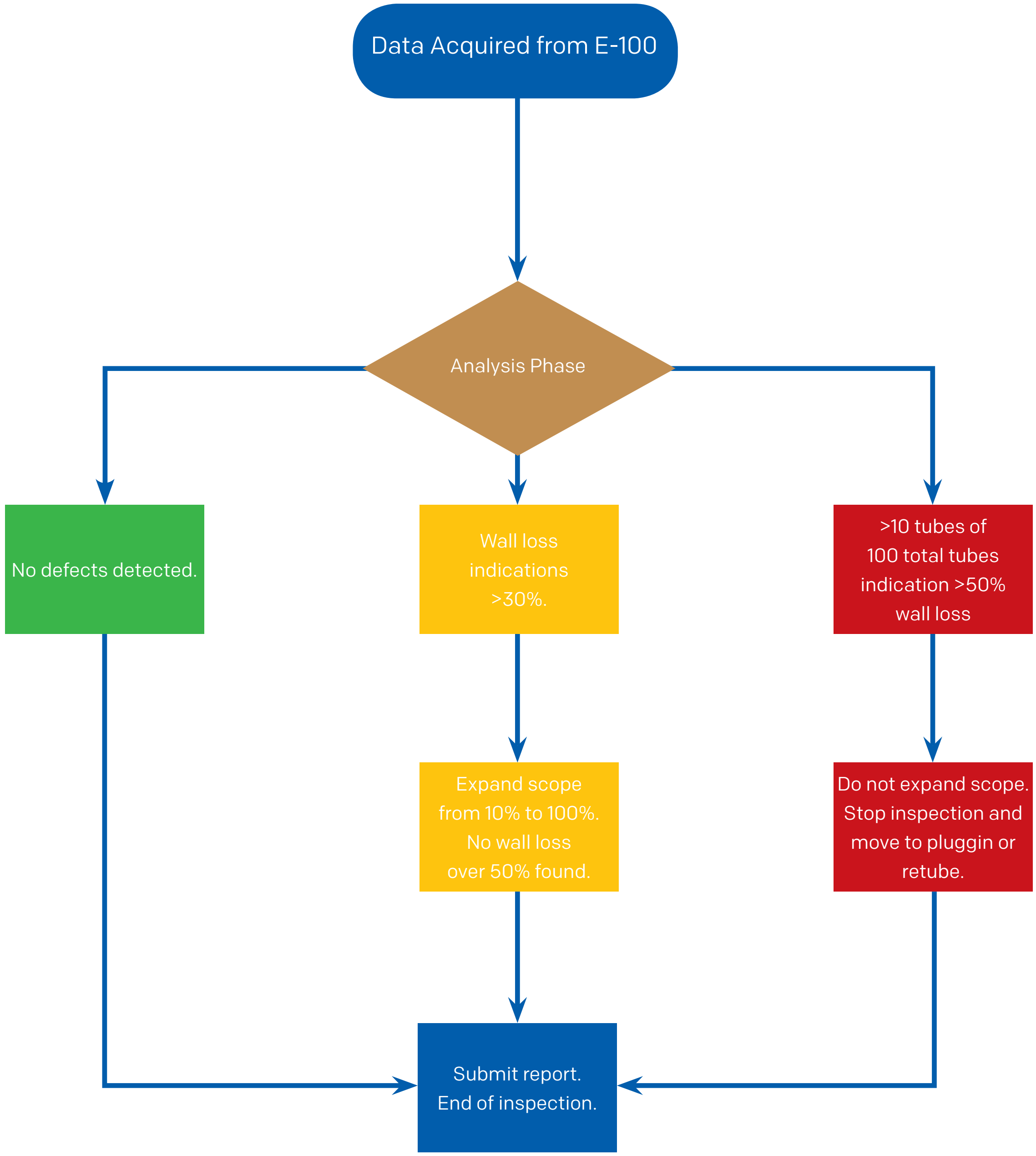

Figure 2. Decision Tree while Tube Inspection activities are in progress in the field.

CONCLUSION

In conclusion, utilizing decision trees can significantly impact time and cost during turnaround scenarios in many different applications. When the decision trees are constructed utilizing the correct data and have clear and concise directions, they eliminate the need for multiple discussions or meetings. They eliminate the downtime between craft disciplines. Properly constructed decision trees can add tremendous efficiencies not only to turnaround scenarios, but to multiple aspects of work progress activities. Utilizing competent inspection personnel as well as engineering personnel to create these workflows is paramount and can result in a safer, more efficient and more successful project. ■

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Zach Burnett is the Operations Manager for Pro-Surve Technical Services, LLC. and ProSource Radiography Services, LLC. Zach has more than twelve years of experience in Advanced Non-Destructive Testing with an emphasis in electromagnetic testing techniques in the oil and gas, petrochemical and utilities industries. His prior experience includes both technical roles as an ASNT Level III as well as Management roles including the oversight of multiple inspection and engineering divisions and personnel. Zach has also maintained responsibilities to maintain profitability of the divisions, personnel and large scale projects he has overseen ranging from large scale turnarounds to holistic Mechanical Integrity implementation projects.