MANAGING INTEGRITY OPERATING WINDOWS AND CRITICAL PLANT LIMITS

HONEYWELL FORGE

TABLE OF CONTENTS

EXECUTIVE SUMMARY

Any business running a process plant wants to maximize asset uptime, reduce maintenance costs and avoid unplanned outages. Operational excellence is becoming an expectation with clear definitions and not just an industry buzz word.

Operational excellence requires a clear understanding of a facility's process variables, operational constraints and production targets.

As industrial organizations expand and optimize operations to meet customer demand in domestic and international markets, they must also maintain their commitment to eliminate accidents, injuries and harm to the environment.

Plant owners and operators are under increasing pressure to achieve greater productivity more efficiently with fewer and fewer resources. Data about plant performance is key to making smart operational decisions. But in most cases, operators have access to only piecemeal information about their units and processes, examining performance without a view to the larger picture of operational targets or safety issues.

Many automated industrial plants now implement some type of operations monitoring program; however, effectiveness of these programs, which is the next logical step to alarm management, can be limited by the use of ad hoc or standalone tools, such as spreadsheet applications that evaluate process variables against operating limits, conduct plant data analysis and perform stewardship reporting.

This white paper examines the issues and suggests recommendations for achieving operational excellence.

UNDERSTANDING OPERATING LIMITS

1

> **An operating envelope is a collection of constraints, boundaries and operating limits in an industrial facility, that when exceeded puts the integrity of assets at risk, even if they are typically based on a combination of factors, such as process unit capacity, equipment constraints and safety concerns. They also can be implemented from launch systems and operating targets.**

According to the Abnormal Situation Management Consortium (ASM), ensuring operations remain within correct limits is central to avoiding many of the root causes of abnormal situations. It was concluded in a recent research that 75% of equipment failure is due to operating outside of these limits. In some cases, those are alarm limits, but in many cases can be that someone was unaware of a limit or when the limit was exceeded, and the proper person or group was not notified to take corrective action.

So, consider the potential, if equipment failure can be reduced by up to 75%, is that a topic worth pursuing?

To maximize the life of an asset in an industrial facility, it must be operated according to design parameters and not simply within process safety limits. That means extending operating strategies beyond operator visibility to entire operations teams and all those interacting with the process.

Without a comprehensive limit management solution, operators lack the insight needed to run plants within the operating envelope of boundaries. Various groups within a plant are responsible for maintaining safe operating limit information. As these variables are often system configuration parameters entered by humans, there is a possibility values may fall outside of safety and compliance envelopes. Additionally, some processes have dynamic safe operating limits that are continually changing, which is challenging for plant operators to manage. As these limits are adjusted for safety and reliability optimization reasons, staff across the facility must have current and updated operations reports to manage site performance effectively.

TERMINOLOGY AND API 584

2

> In order to operate any process unit, a set of operating limits and ranges needs to be established for key process variables in order to achieve the desired results. Examples would likely include product within specifications, safe operations, or reliability. These limits are generally called operating limits or operating envelopes.

An Integrity Operating Windows (IOW) is a specific subset of these operating limits that focuses only on maintaining the integrity or reliability of process equipment. Typically IOWs address issues that involve process variables that, when not adequately monitored or controlled, can impact the likelihood and rate of damage mechanisms, which may result in the loss of containment.

The American Petroleum Institute (API) has developed Recommended Best Practices 584, which addresses certain limitations in maintaining the integrity of a process unit. Within API 584, the term **maintaining integrity** means avoiding breaches of containment. **Reliability** means avoiding malfunctions of the pressure equipment that might impact the performance of the process unit with regard to meeting its intended function for the specified timeframe.

A properly structured, efficient and effective inspection program depends on IOWs being established and implemented to improve inspection planning and to avoid unanticipated impacts on pressure equipment integrity. Inspection plans are typically based on historic damage mechanisms and trends that are not generally assigned to look for anticipated damage resulting from process variability and upsets. Inspection plans generally assume that the inspection interval, which is calculated based on prior damage rates from past operating experiences, are scheduled on the basis of what is already known and predictable about the equipment aggregation from previous inspections.

Without a set of effective and complete IOWs in the feedback loop for the inspection planning process, inspections might need to be scheduled on a more frequent time-based interval to look for anything that might occur within the process variability.

IOW DEFINITIONS

API 584 defines three severities for IOWs:

- Critical,
- Standard, and
- Informational.

An IOW Critical Limit is a level that, if exceeded, rapid deterioration could occur such that the operator must take immediate predetermined actions to return the process variable back within the IOW in order to prevent significant defined risk of potential equipment damage, and a hazardous fluid release could occur in a fairly short timeframe. Defined as an IOW Critical Limit, it may also be referred to as Safe Operating Limit or Safety Critical Limit.

An IOW Standard Limit is an defined as a level that, if exceeded over a specified period of time, could cause increased degradation rates or introduce new damage mechanisms beyond those anticipated. Since the timing of the impact of the exceedance of a Standard IOW Limit can vary significantly, the notification and response to an exceedance can also vary.

For higher risk exceedances, alarms or alerts potentially are needed, and the operator may have some predetermined actions to take. For lower risk exceedances, alerts may only be needed for eventual interaction with operating supervisors or appropriate technical personnel and subject matter experts (SME).

IOW Standard Limits may also be known as Operating Limits or Reliability Limits.

API 584 defines IOW Information Limit as an established limit or standard operating range for other integrity parameters that are used primarily by SMEs to predict and/or control the longer term integrity/reliability of the equipment.

Information Limits are typically tracked by the appropriate SMEs, process engineer, or corrosion specialist, and may or may not have alarms associated with their exceedances. In some cases, informational IOWs are used for parameters that cannot be directly or indirectly controlled by operators. An operator's primary duty would be to see that any exceedances are communicated to the designated SME for attention and corrective actions, if there are any.

A Critical IOW Level is must be urgent to return the process to a safe condition. The key differentiation for a Standard IOW Level when compared with a Critical IOW Level is the time period. If something continues to operate beyond the envelope, then actions should be taken. Examples of Standard IOW Levels might include:

– Eventual loss of containment,

– A release of hydrocarbons or hazardous fluids,

– Unscheduled or non-orderly shutdown,

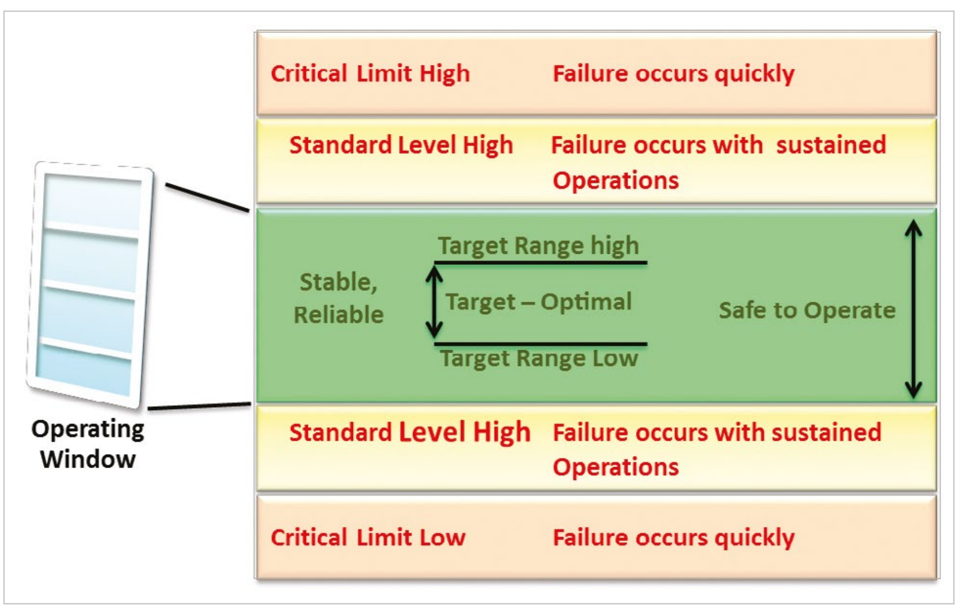

Figure 1: *Zones of operation including target ranges with standard critical limits.*

– A negative impact to the long term unit performance and its ability to meet turnaround run length, or

– Unacceptable financial risk.

Informational IOW Levels may or may not have an intervention. Examples include deviations that could eventually lead to:

– Accelerated corrosion or other damage over a longer period of time,

– A condition that would not be related directly to a potential loss of containment within the near term,

– A secondary indication of operational performance or corrosion control issue, and/or

– Track parameters that are not necessarily controllable by operators.

THE OPERATING WINDOW

API 584 offers a way to visualize the criticality of IOWs, as illustrated in Figure 1. Operators need to know where all of the limits are and how to react. In a real life example, target range and standard or critical lmis may be tightly bunched. The operator may not have time to react in some situations.

The API recommendations include a simple method for looking at consequence and probability to help evaluate risk (see Figure 3). Within API 584, optimal and target levels are illustrated, showing examples of IOWs and expected responses. The full set of recommendations may be viewed or downloaded at this **link**.[1]

According to 584 best practices, the number of IOWs for a typical process unit might range from 20 to 60, depending on the issues. Procedures are necessary to store the IOWs and notify the operator when an exceedance has occurred. Certain situations involve additional monitoring and control instruments and/or sampling points for some IOW variables. Additionally, capital investment for monitoring and sampling systems and/or increased workload for laboratory analysis may be involved.

Some of these IOWs might be alarm limits. How does your organization deal with IOWs? Do you know what they are and, if exceeded, who will respond – the operator, SME, or others being notified in a timely manner, according to the recommendations from API 584?

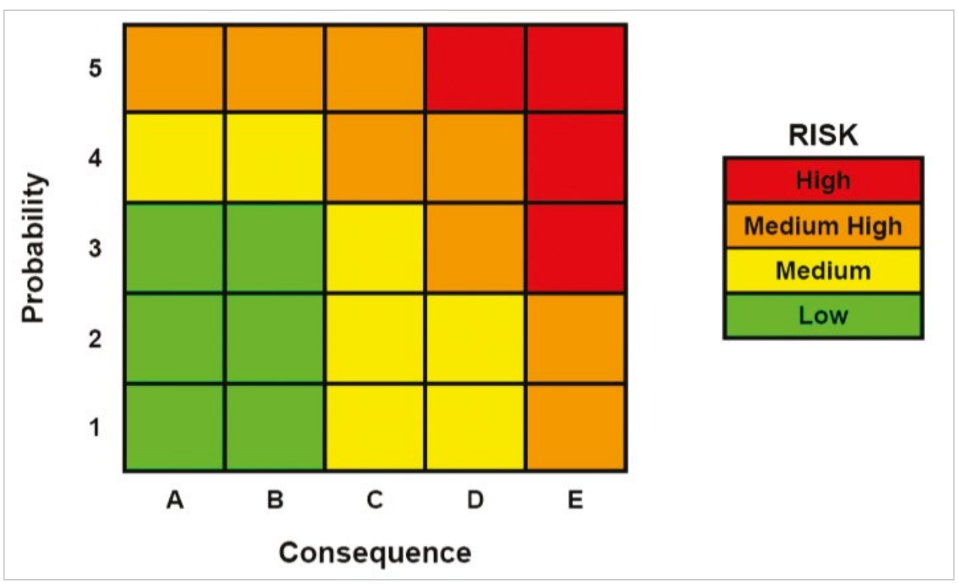

Figure 2: *Generic Risk Matrix for Assessing IOW levels.*

API 584 documentation provides recommendations as to roles, responsibilities, and accountably for IOWs. Included are inspection, corrosion/materials, operations, process engineering/technology, plant management, process safety management, laboratory, control systems, and mechanical and/or reliability engineers. Many different "eyes" need to look at IOWs. How is this handled cohesively?

A de-salter in a crude unit is designed to operate at up to 350 degrees, but the corrosion rate increases noticeably when operated above 300 degrees.

Figure 3: *Prime example where an IOW might be established.*

A QUICK ANALYSIS

Can you respond to the following questions?

– Are operating plans being met?

– Where are the safety, process, design, and reliability and environmental limits, and are these limits in effect consistently?

– Are plans or limits are being violated? Why?

– How can process performance and unit reliability be improved?

If these questions were asked of the people assigned roles and responsibilities (inspection, corrosion/materials, operations, process engineering/technology, plant management, process safety management, laboratory, control systems, and mechanical and/or reliability engineers), would they know the answers or where to find them?

AN EXAMPLE OF AN IOW

Referencing the example in Figure 3, most organizations would consider this situation and say that 350 degrees is an alarm limit that should be established. If the temperature goes above 350 degrees, then the alarm will go off and the associated severity for that alarm would indicate whether the operator should intervene to bring the temperature back below 350 degrees. The one thing organizations often forget is some of the equipment nuances. In this example, the corrosion rate for this particular desalter increases at about 300 degrees.

API 584 would recommend that an IOW might be established (perhaps a standard IOW), where, if temperature goes above 300 degrees, the operator is at least notified that a higher rate of corrosion is happening at this temperature and that he/she should be looking at ways to bring the temperature down.

A HOLISTIC VIEW OF IOWS

The question now becomes: how to find the holistic view of IOWs, getting standard IOWs in place, and so forth? To answer this question, Honeywell has developed the Operations Monitoring module, part of the Honeywell Forge Operations Management offering.

Operations Monitoring systematically monitors process plant performance data and summarizes deviations (Figure 4). The software then notifies operators when they are operating outside the best operating zone, and can provide guidance to return the process to it. In most cases, these limits are set within the operating window for the operating sweet spot. Because of that factor, the software focuses on maintaining a process within the best operating window that gives the most "bang for buck, while staying within alarm limits."

Because deviations from best operating zones occur within alarm limits, it is important that alarm system performance itself is also maintained. Consider a situation where an alarm system is performing poorly and the operator is continuously trying to respond to a large number of critical or high level alarms, During these situations, an operator must focus on avoiding a process upset and would not be in a position to run the process optimally within best operating zones.

However, for organizations that have their alarm management under control, using Operations Monitoring can be implemented with good results.

One of the key aspects of Operations Monitoring is its ability to visualize the operating envelope or best operating zone as well as get information about how to address a deviation from a configured limit (Figure 5).

When a deviation does occur, the typical work process practices require the operator to enter information that will add context to that deviation for the engineers and others who will analyze this information for actions. This documentation can be done easily with Operations Monitoring, enabling operators and subject matter experts to capture, report on and analyze additional deviation information in a consistent and auditable manner across the organization.

With Alarm Management, the operator is working to keep the process inside a wide operating zone designed to avoid an abnormal situation. With Operations Monitoring, the operator is shown the best operating zone that allows the process to run efficiently, meet plans, avoid unplanned downtime, and keep equipment reliability high and maintenance costs lower.

Without Alarm Management, which is a best practices tool as well, operators are too busy responding to nuisance alarms. Following the implementation of Alarm Management, the next steps would be the implementation of Operations Monitoring.

Operations Monitoring added to a healthy alarm system allows for operating in the tighter best operating zone. This approach improves performance and can be seen in a similar light as Alarm Management. While Alarm Management protects equipment and people, Operations Monitoring will help protect efficiency and profitability gains.

Operations Monitoring helps present a single consistent view. The software can display all of the limits associated with a process variable. Not only can the software show any Informational, Standard or Critical IOWs that are set by anyone within the system, it also brings in alarm limits. Now, it is possible to have a consistent view in terms of where the process is operating currently, where the process limits are, and where the Operations Monitoring limits are.

Referring to Figure 7, It is possible to observe that some of the lower limits established are tightly packed together. If the SME is viewing this display, this holistic view might give them a different action in terms of limits set at 195 and also one set at 165.

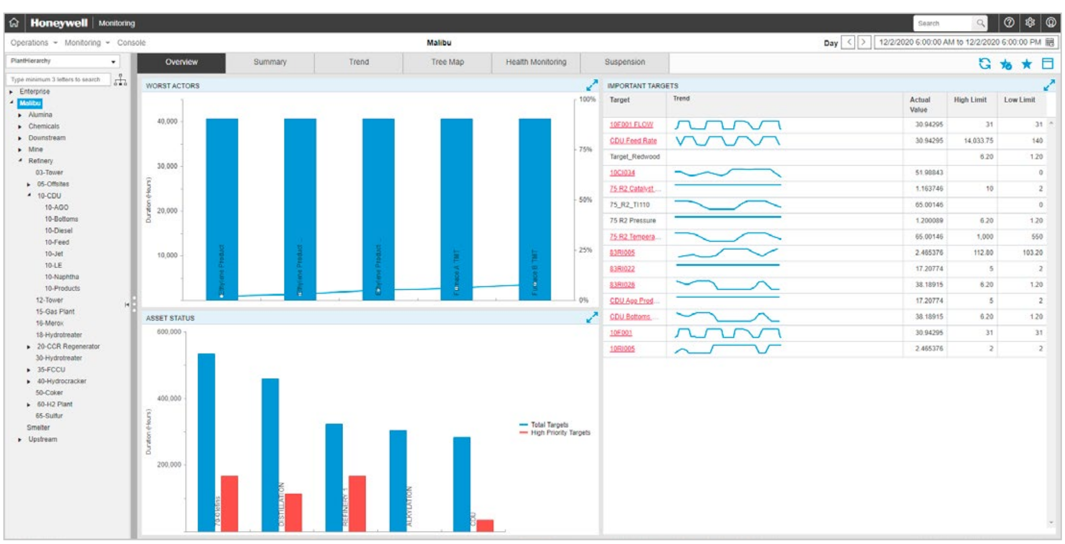

Figure 5: *Operations Monitoring has the ability to visualize the operating envelope.*

Does the operator get one notification to do something, and is it too short a time before they get another alarm regarding the second IOW or alarm limit?

The software has a central repository for alarm limits and any limits that have been established with regard to best practices like API 584. Planners, operators, equipment specialists, or alarm management specialists can all be working on their own PCs, entering information about IOWs and alarm limits into the limit management repository. The control engineer and the operators will be viewing the same information regarding where the process variables are currently.

Operations Monitoring allows work process and practices for users other than operators to use the system as well. Engineers, supervisors, reliability engineers, planners and others can monitor where problems are most prevalent. Displays provide easy mechanisms to keep tabs on such things as worst actors and important targets. Important targets can be defined within the software through specialized dashboards that, when specified roles are logging in, those targets will be shown so someone is mindful of those important targets at all times. An alternative visualization, such as tree maps, is also available for users that find that sort of interface effective to use.

A set of tools support work processes for users such as engineers (not for operators, typically) who need to be aware when deviations that concern them have occurred. Notification capability allows the users to receive emails and appropriate other alerts where limit deviations have occurred. Engineers are also able to provide remote operations assistance with the ability to log in from anywhere.

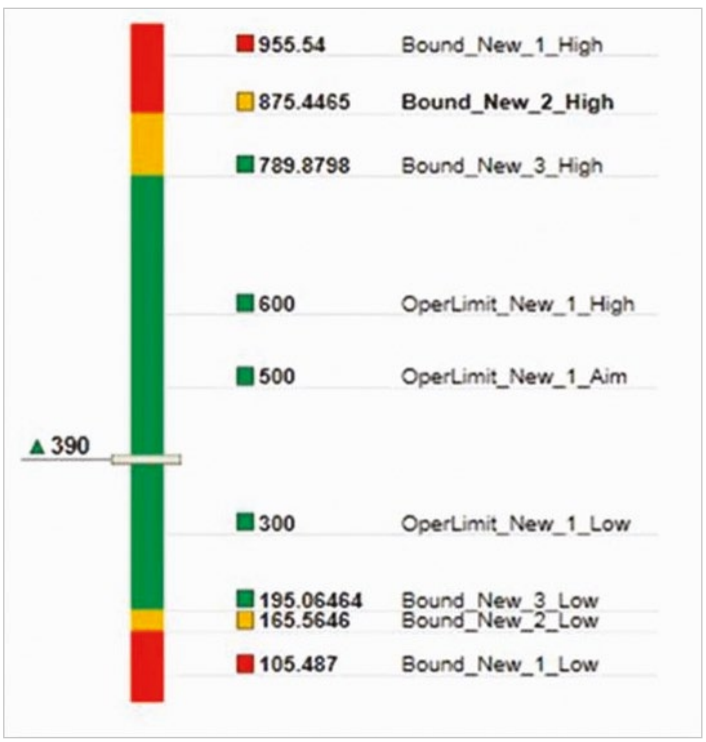

Figure 7: *Single view derived from a comprehensive set of limits.*

Having the ability to report on deviations enables organizations to better understand the financial impact of deviations to their operations. For instance, on a shift basis, the software can analyze how many deviations have occurred, and based on selected criteria, calculate financial impact, and generate a report such as the example in Figure 8. In this example, the largest red block indicates that the particular asset or process unit is costing the most money in terms of the number of deviations that occurred. This is an area that the organization should focus effort to understand why the deviations occur, reduce the occurrence of them, and reduce financial impact.

A QUICK ANALYSIS – REVISITED

With tools such as Operations Monitoring, these questions should be easy to answer.

– Are operating plans being met?

– Where are the safety, process, design, and reliability and environmental limits, and are these limits in effect consistently?

– Are plans or limits being violated? Why?

– How can process performance and unit reliability be improved?

In the previous example with the de-salter, using Operations Monitoring, a limit at 300 degrees would be set, and when that limit is surpassed, notice of a deviation is sent to the operator

The operator can inspect the deviation and determine why it exists in relation to alarm limits and any other IOWs. That investigation would inform the operator that this deviation affects corrosion rates, and so return the process to below 300 degrees. The alarm limit is still set at 350 degrees.

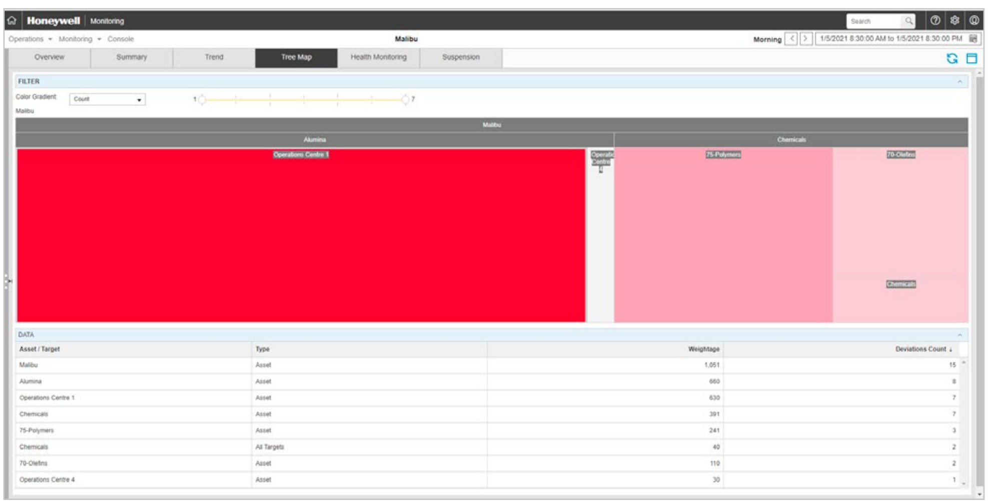

Figure 8: *This display shows the eight hour period prior to the request for selected units from the Refinery and Chemicals plants. The color coding helps the viewer to determine very quickly where attention is needed.*

SUMMARY

Effective use of Operations Monitoring will help organizations in many ways. Consider:

- Engineers, lead operators, and other staff meet every few weeks or months to review reports and comments entered by operators when considering updates to safe operating limits throughout the plant.
- Process data is monitored regularly and any deviations outside operating limits are recorded.
- Operators enter comments about important deviations by the end of the shift.
- Monthly stewardship reports are available with information such as the total number of deviations, the top ten process variables in each unit with the most problems, and the top reasons why deviations occurred.

The value of using Operations Monitoring will vary by organization, but it can be substantial. Honeywell has observed the following results from customers using operations best practices and Operations Monitoring:

- **Efficiency:** Meeting production plans and staying within energy efficiency limits – Typical result: 5% better energy utilization;
- **Unplanned Downtime:** Research shows that up to 76% of equipment failures are a result of operating equipment outside of range or design envelopes – Typical result: 20% - 80% (50% average) reduction;
- **Environmental, Health & Safety Compliance:** Address a wider range of causes of process upsets to improve EHS Compliance - Typical result: Reduce the number and cost of incidents up to 50%; and
- **Technology Costs / Effort:** Eliminate custom-built spreadsheet monitoring and reporting tools – IT resource drain to maintain - Typical Result: Reduced IT effort by one man-year.

To gain the expected results requires a commitment to best work practices and process, with training and organizational buy-in.

REAL WORLD EXAMPLE

A major Asian energy producer was searching for new solutions to avoid incidents and improve personnel productivity. This company partnered with Honeywell on an ambitious program to implement operations management strategies, including the latest Operations Monitoring application, across its large scale refining facilities. The undertaking has resulted in significant improvements in reliability, fewer unanticipated shutdowns, and greater overall productivity. The company expects to realize $12 - $14 million dollars in annual operational improvements.

Even though this example is for a very large refinery, the results signify that, when best practices and software are implemented, significant financial benefits can be realized.

HONEYWELL FORGE OPERATIONS MANAGEMENT

Part of Honeywell's Enterprise Performance Management (EPM) offering, Honeywell Forge Operations Management provides the foundation needed to enable operations excellence. Honeywell is an industry leader in integrated Manufacturing Execution Systems that improve plant profitability by enabling plant staff to work more effectively and make better decisions.

WHAT IS ENTERPRISE PERFORMANCE MANAGEMENT?

EPM is a set of tools that collect, unify, and take action on operational data to optimize performance, sustainability, and safety at the enterprise level.

CHALLENGES EPM ADDRESSES

- Operate within Safety, Quality Regulations
- Improve productivity
- Improve operational consistency across crews
- Sustain long-term benefits
- Solve plant-level process optimizations
- Reduce the gap between production and planning

For More Information

Learn more about how Honeywell Forge Operations Management can help in managing plant limits, visit our website www.hwll.co\operationsmanagement or contact your Honeywell account manager.

Honeywell Connected Enterprise
715 Peachtree Street NE
Atlanta, Georgia 30308
EUR +44 (0) 162 562 62 50
USA +1 208 921 9867

WP-20-20-ENG | 01/21

THE FUTURE IS WHAT WE MAKE IT

Honeywell