AN INTRODUCTORY GUIDE TO RUST PROBLEM SOLVING PROCESS

How to use a defined problem solving approach to identify and eliminate the root cause while optimizing the process (ie elimination of waste)

A publication of

ZIMMARK
TECHNICAL PROCESS MANAGEMENT

Introduction

Inside This Issue

""Everything is a process, even problem solving. Sample, test, interpret, make a correction, repeat. The trick is to know what to sample, what tests to perform, how to interpret the results and how to efficiently make the corrective actions. Combine the Wisdom to properly interpret with the Business Process to efficiently execute, and you're left with optimization." – Z-Einstein

Z-Einstein

Is this guide right for you?

This guide is specifically designed to help Automotive Parts Manufacturers who are looking to provide and sustain temporary rust protection on the cast iron and steel parts they produce. In a changing and dynamic manufacturing environment, it can be a real challenge to control all the variables that can come into play when applying temporary rust protection to parts prior to their receiving a permanent solution (ie paint, or coatings) while still optimizing cost. Companies tend to either spend far more on rust protection than they need to or in an effort to manage costs, they leave their parts vulnerable to corrosion when conditions on the floor change.

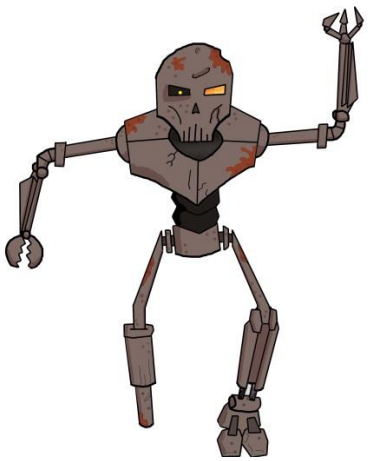
This guide is meant for those looking to address corrosion that might occur in-process between manufacturing steps, those looking to ensure that the parts they ship to their customers arrive rust free every time or those looking to eliminate all the waste that has been introduced into the process in an attempt to address random corrosion events.

Rust is a predictable and repeatable chemical reaction. By understanding the factors that impact the opportunity for corrosion as well as the rate of corrosion is essential if a plant is looking to provide the necessary protection while still managing its costs.

This guide is for the Plant Manager that's tired of periodic rust appearing on their parts, the Engineering Manager that's tired of the insecurity that comes from changing several variables all at once in reaction to an rust event never truly identifying the true root cause(s), or the Quality Manager that is tired of adding non-value add costs to the manufacturing process because the mechanisms of the formation of rust at the facility are not truly understood.

This guide is for you.

Rust Problem Solving Process



Rusty

- Stage -1- Establishing a Rust Team, Plan & Goal
- Stage -2- Rust Problem Definition
- Stage -3- Rust Containment Actions
- Stage -4- Determine the Root Cause of Rust
- Stage -5- Rust Corrective Action
- Stage -6- Rust Correction Verification
- Stage -7- Standardization & Rust Prevention

Stage -1- Establishing a Rust Team, Plan & Goal

> "People in any organization are always attached to the obsolete - the things that should have worked but did not, the things that once were productive and no longer are." — Peter F. Drucker

Membership Should Include

- Stakeholders - (Managers – Quality/Engineering/Production/Suppliers/Customer)
- Knowledgeable people / technical experts - (Chemical Eng./Process Eng./Maintenance/Operators)
- People accountable & responsible for problem areas - (Supervisors/Operators/Managers)

Team Size

- Ideally 4 to 6 members

Additional Considerations

- Do customers or suppliers affected by the rust problem need to be on the team?
- Do you have a team member who can effectively facilitate the rust problem solving process?
- Do you have in house chemical/technical expertise to perform effective root cause analysis of the rust problem:

Establish a Rust Team :

Having the right team involved in your rust problem solving process is critical to ensure effective problem identification, the implementation of a multifaceted corrective action and the discipline/authority to ensure those actions are sustainable over time.

Plan:

Preparation and planning is required to ensure an effective and efficient rust problem solving exercise. Before starting there are a few items that should be prepared:

- Customer complaint information
- Parts or pictures of the rust reject
- Rust fallout / Inspection data
- Supporting process parameter data (Process Map, FMEA, Control Plan, Inspection Logs)
- Part history (Has there been a rust problem with this part before?)

Goal:

Since the rust problem solving process is a team exercise, it is important to establish a team goal that everyone can be focused on accomplishing. It is therefore essential to clearly define the project deliverables that you wish your rust problem solving team to accomplish. An example of this could be to:

"Determine the Root Cause of the rust problem and permanent corrective action to ensure it does not happen again."

Remember that it is easy for the team to get trapped in targeting the rust symptoms and adding band aid fixes that provided temporary solutions and add cost to the process but do not eliminate the rust problem from happening again. Often entire unit operations are added to the manufacturing process in an effort to address an intermittent rust occurrence.

Stage -2- Rust Problem Definition

Develop Your Rust Problem Statement:

> "The most serious mistakes are not being made as a result of wrong answers. The true dangerous thing is asking the wrong question." — Peter F. Drucker

Having a clear and objective problem statement helps the team to focus on the correct path to determine the root cause and solution. The statement should be based on data and not speculation and include the current state of the rust problem, the desired state, and the gap or the difference between the current and future state that you desire the team to accomplish.

"Company XYZ has been receiving widgets with rust spots on the face of the part between the time period of May 4th to May 17th at a fallout rate of 25 to 46%. In order to meet XYZ requirements, the widget must be free from rust upon arrival and maintain a 30 day rust free shelf life."

Pictures Data & Rust Information:

Obtaining pictures and/or parts with the rust problem is the first step in leading your team to the root cause analysis. Understanding the rust formation, location and quantity is crucial information to determine the potential causes in your process of the rust problem.

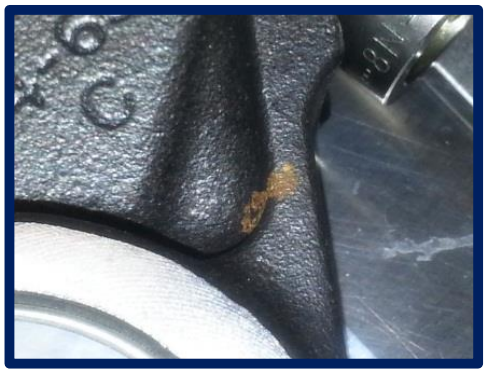
What to look for:

Rust Formation

- Light/flash rust, easy to remove from metal surface
- Heavy/pitted rust, hard to remove from metal surface

Rust Location

- Machined surface
- As-cast surface
- Spotty in areas were fluid has pooled
- Top, bottom sides of part
- Top, bottom or middle of the skid/pack

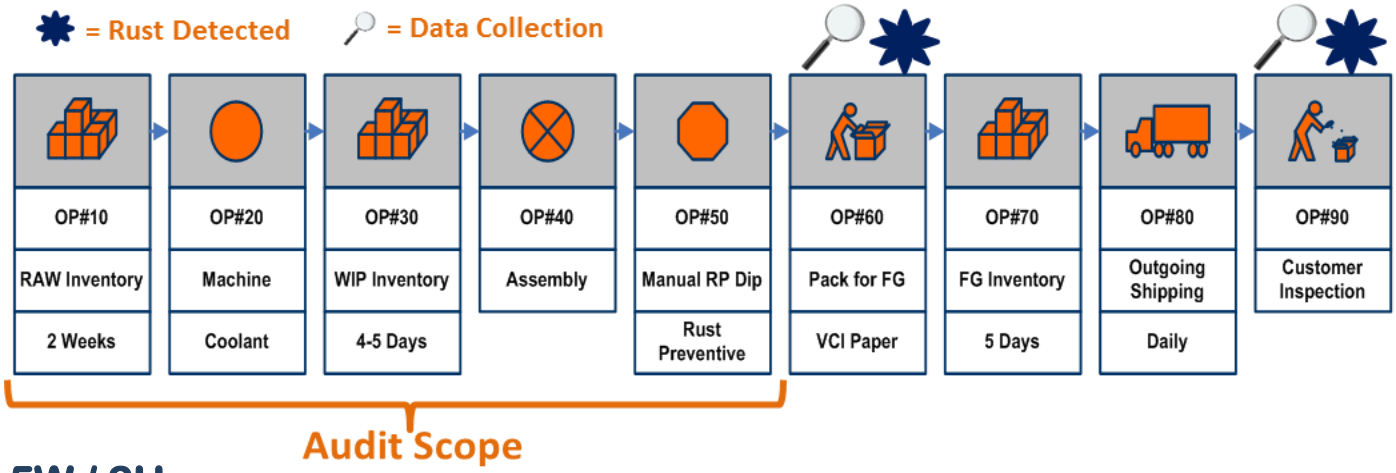


Rust Occurrence

- Random/Cyclical/Continuous
- Manufacture lot/batch specific
- Ship date specific

Process Mapping:

Mapping the process from beginning to end is an excellent visual tool to communicate to the team process steps, parameters, rust detection locations and audit scope.



5W / 2H:

The who, what, why, where, when, how many and how often of the rust problem.

Who

- Who is affected by the rust?
- Who first observed the rust?

What

- What has the rust?
- What is happening with the process & with containment?
- Do we have physical evidence of the rust?

Where

- Where is the rust being detect?
- Where does the rust occur?

When

- When was the rust first noticed?
- When has it been noticed since?

How Much/Many

- How many pieces?
- How many occurrences?

How Often

- What is the trend
- Has the rust occurred before?

> "It is a capital mistake to theorize before one has data. Insensibly one begins to twist facts to suit theories, instead of theories to suit facts" — Sherlock Holmes

Zerlock

ZIMMARK TECHNICAL PROCESS MANAGEMENT

Stage -3- Rust Containment Actions

"The best way to predict your future is to create it" — Peter F. Drucker

Containment actions may include

- Manual 1st or 3rd party sorting or screening
- Rework & reprocessing of parts
- Expedited shipments
- Additional VCI packaging
- Additional desiccant material added to packaging
- Additional rust preventative applications
- Increased fluid concentrations from control plan
- Unplanned machine or washer fluid dump and recharge

Short Term Corrective Action:

To ensure the rust impact to your customer is minimized, containment and short term corrective actions may be needed. The objective is to take immediate action to prevent rust from impacting your customer while the problem solving team determines the root cause and identifies the permanent corrective action. Typically these short term actions involve additional process steps or parameters.

It is important to remember, that containment actions are not long term solutions to your rust problem. They often add cost & introduce waste to the process. It is best practice to capture each containment action so that they can be eliminated in the future once the root cause and long term corrective action is identified and implemented.

Containment Action Deck:

Often times multiple containment actions occur during a rust problem event. Organizing and tracking these action items helps ensure team members understand the task, responsibility and target completion date. Maintaining a list also assists in eliminating these wasteful steps once true root cause is identified and corrected.

Containment Action Deck

Item #	Action	Task Description	Responsibility		Status	Start Date	Finish Date	Target Date	Comments
1	Sorting & Part Certification (Customer)	Contact customer to determine quantity of suspect material on hand in inventory	Widget Inc.	J. Smith	Complete	05-May-12	05-May-12	05-May-12	12000pcs on hand
		Determine certification criteria and material identificati	Widget Inc.	J. Smith	Complete	05-May-12	06-May-12	06-May-12	Pink Placards, Pink Dot
		Contact 3rd part sorting company & begin screening at XY	Widget Inc.	J. Smith	Open	05-May-12		08-May-12	
2	Sorting & Part Certification (Internal)	Quarantine internal material and determine suspect qua	Widget Inc.	J. Smith	Complete	05-May-12	05-May-12	05-May-12	25,000pcs on hand
		Training internal personal on inspection & certification c	Widget Inc.	J. Smith	Complete	05-May-12	06-May-12	06-May-12	Pink Placards, Pink Dot
3	Rework	Determine rework process	Widget Inc.	L. Gilbert	Open	05-May-12		08-May-12	
		Get customer approval for rework process	Widget Inc.	J. Smith	Open	05-May-12		09-May-12	

Cost of Poor Quality:

When calculating the Cost of Poor Quality resulting from a rust event, it is important to identify all the elements that contribute to the total cost. Cost of containment often gets left out, but should be identified and added to the calculation. Identifying a true total cost is an effective exercise since it helps to communicate to the team the real impact of the problem. This helps everyone understand the severity of the event and can aid with justifying the cost of permanent corrective actions in the future.

Cost of Poor Quality					
Internal Costs					
Item	**Qty**	**$**	**$/hrs**	**$/pcs**	**Total Cost $**
FG Scrapped	914	$ -		$ 12.40	$ 11,330.00
WIP Scrapped	500			$ 7.50	$ 3,750.00
Rework Pieces					$ -
Rework Hours	60		$ 16.45		$ 987.00
Rework Supplies	1	$ 150.00			$ 150.00
Containment Sorting	40		$ 16.45		$ 658.00
Containment Administration	16		$ 45.00		$ 720.00
Containment Supplies					$ -
Additional In-Process Inspection					$ -
Additional Setups					$ -
Additional Overtime					$ -
Problem Solving Admin					$ -
3rd Party Sorting					$ -
Additional Freight / Expedites					$ -
				Total Internal Cost :	**$ 17,595.00**
External Costs					
Item	**Qty**	**$**	**$/hrs**	**$/pcs**	**Total Cost $**
Parts Rejected/Returned	126			$ 26.70	$ 3,364.79
Containment Sorting	80		$ 32.50		$ 2,600.00
Containment Administration					$ -
Containment Supplies					$ -
Additional In-Process Inspection					$ -
Additional Freight / Expedites	3			$ 750.00	$ 2,250.00
Additional Customer Debit's					$ -
				Total External Cost :	**$ 8,214.79**
				Total COPQ :	**$ 25,809.79**

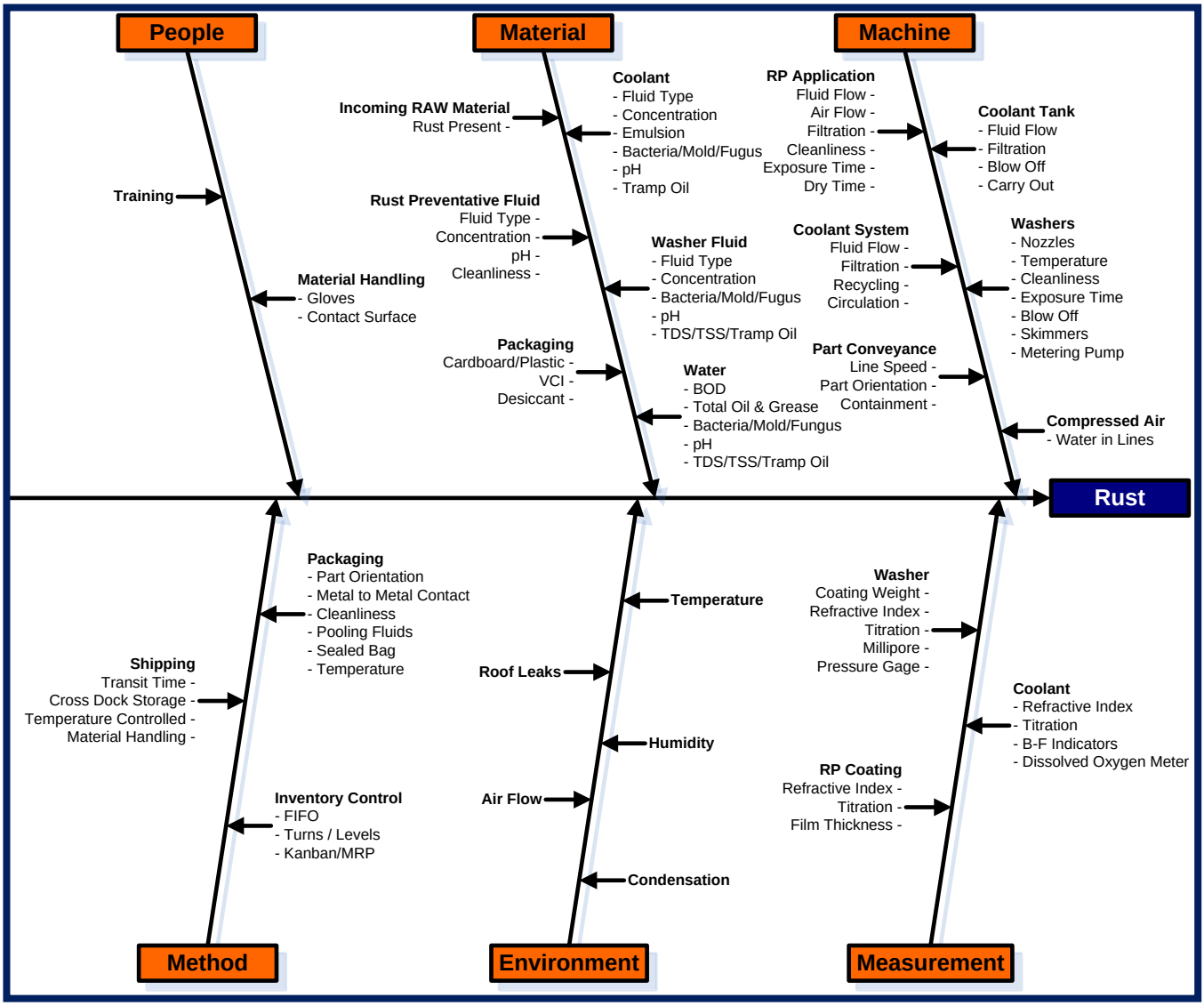
Stage -4- Determine the Root Cause of Rust

Cause & Effect Analysis:

Performing a team brainstorming exercise such as the cause & effect analysis is a great tool for identifying, exploring and displaying all the possible causes to the effect (rust). There can be many variables (causes) that can potentially lead to rust (effect), having qualified technical personnel on your team and process data is vital in ranking the likely causes to your rust problem. In most cases, it's a combination of causes that result in the event, making their identification even more challenging.

Execution

1. Brainstorm the possible cause (s) of the problem
2. Rank the possible cause (s) and collect supporting data from your process
3. Select the potential root cause (s) & target (s)
4. Run tests to verify root cause (s), ideally turn "on and off" your rust problem by targeting the cause



ZIMMARK TECHNICAL PROCESS MANAGEMENT

5 Why Analysis:

The 5 Why analysis tool works with the Cause & Effect analysis to help your team pin point the root cause of your rust problem. By asking the question "why" five times (best practice rule of thumb) you can peel away the layers of symptoms that are causing your rust problem.

Benefits of the 5 Whys:

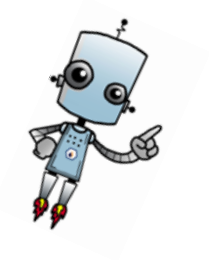
- **Helps to identify the root cause of the rust problem**
- **Illustrates the relationships between the different root causes of the rust problem**
- **Simple tool to use and teach to your team**

5 Why Analysis					
Problem Description :	Company XYZ has been receiving widgets with rust spots on the face of the part between the time period of May 4th to May 17th at a fallout rate of 25 to 46%. In order to meet XYZ requirements widget must be free from rust upon arrival and maintain a 30 day rust free shelf life				
Why 1	**Why 2**	**Why 3**	**Why 4**	**Why 5**	**Root Cause**
Rust is occurring after shipment	Parts are rusting during shipment to customer warehouse	Parts are shipped Friday and received Monday (3 days transit)	Truck trailer has an uncontrolled environment	Temperature & humidity fluctuations can cause condensation which leads to rust	**Condensation is occurring inside the packaging during transit**
		Film coating from rust preventive inadequate to protect metal surface during shipment	RP is applied after a wash bath process using a manual dip tank method	Part exposure in RP dip tank is 1 - 2 seconds per part	**Parts exposure time should be a minimum of 60 seconds in RP tank to ensure wash chemistry is fully demulsified from the metal surface**
				RP dip tank is cleaned out weekly, fluid contamination from wash chemistry effecting RP coating	**Heavy wash contamination in RP tank is interfering with the RP ability to form an adequate coating on the metal surface**
				Parts are packed in finish goods wet with pooling RP	**Pooling RP still contains the solvent carrier that does not provide prtoection on the metal surface, RP must be dry before pack**

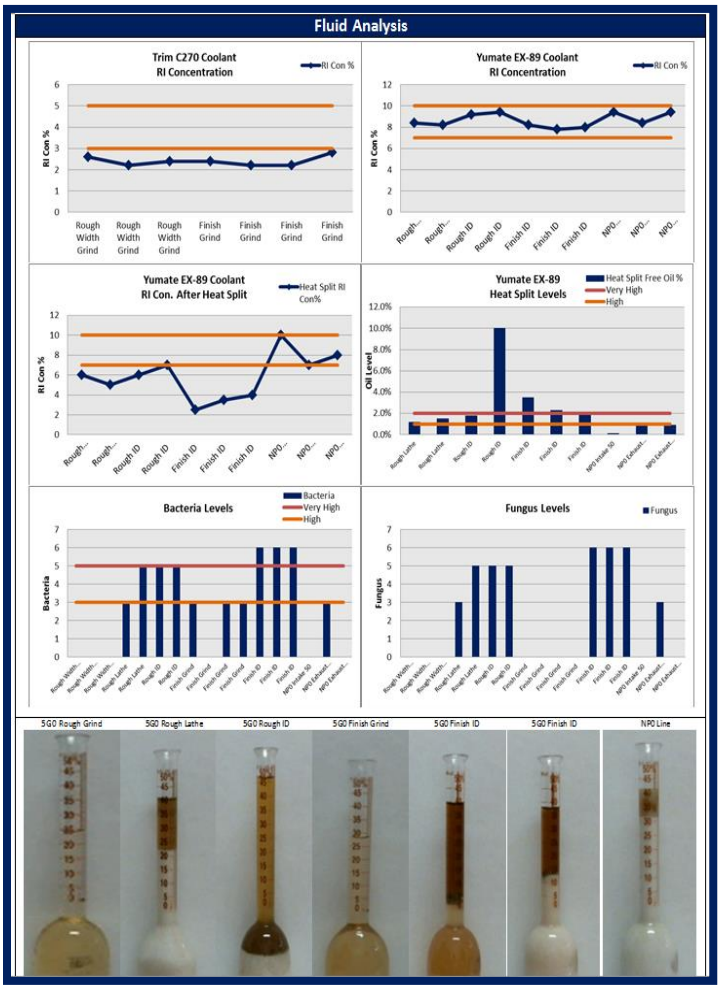
Root Cause Verification:

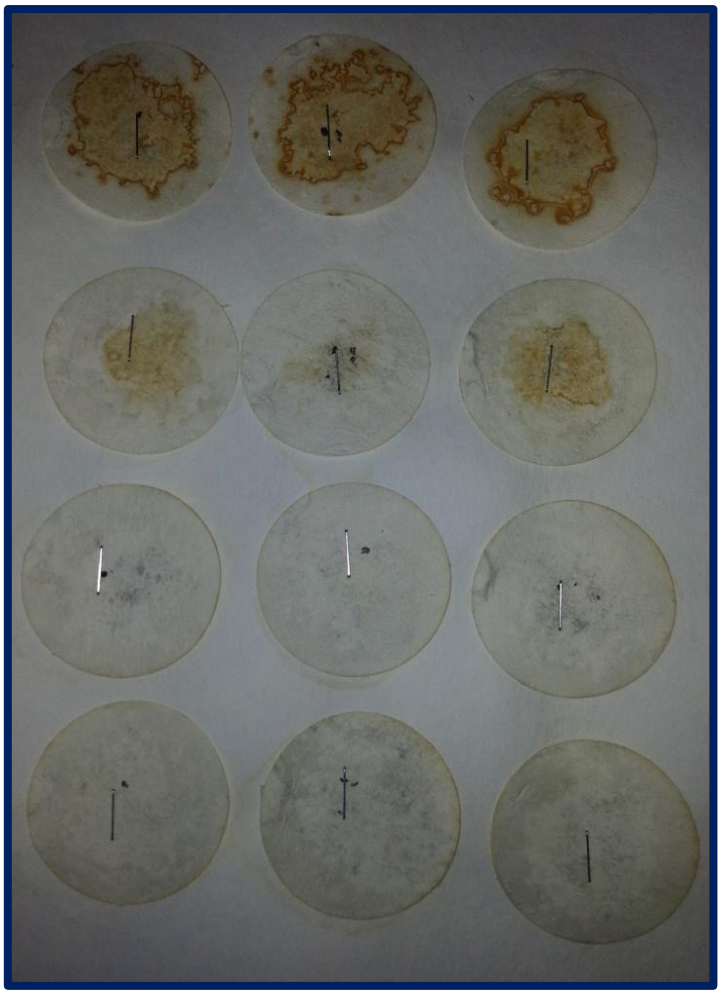
The last step in Stage 4 is to verify your rust root cause before determining a permanent corrective action (s) plan. There are many different methods in accomplishing verifications, common ones such as DOE require technical knowledge and resources to ensure they are completed timely and efficiently. The main goal during verification is to turn your rust problem "on and off" to ensure the correct variable (cause) has been identified. Similarly to Stage 3 where multiple containment actions are needed, multiple verification testing may be required to verify root cause. Organizing and tracking these action items with an Action Deck helps ensure team members understand the task, responsibility and target completion date.

Common Rust Verification Test Methods



- **Laboratory Fluid Analysis** - To verify fluid parameters (causes)
- **Laboratory Heat & Humidity Cabinet Testing** - To accelerate test time
- **Laboratory Cast Iron Chip Test** - To turn on & off rust (effect)
- **Technical Process Parameters & Inspection Data Review**





ZIMMARK
TECHNICAL PROCESS MANAGEMENT

Stage -5- Rust Corrective Action

> "Knowledge has to be improved, challenged, and increased constantly, or it vanishes" — Peter F. Drucker

Rust Corrective Action Implementation:

Where the last step in Stage 4 is to verify your rust root cause before determining a permanent corrective action, Step 5 is about implementing that corrective action in a sustainable way, where the solution is incorporated in the on-going control plan for the process. Since these are permanent corrective actions, they have to be made efficient and free of any unnecessary waste,. They are not short term containment steps, step 5 is about building the checks and balances into the work flow of the piece. It needs to take advantage of existing systems and infra structures. It requires follow up and ongoing control . It requires optimization over time.

Keys to Communication

- Action Decks to ensure criteria, responsibility and timing is of all corrective actions, to ensure they are well understood by the team members
- Communicate root cause and corrective action plan to all affected parties (ie Customer)

Risk Assessment / (FMEA) Failure Mode Effect Analysis

FEMA's serve several purposes. They can be used to help identify any short comings or risks in the process that may still remain that weren't necessarily identified in this specific investigation. By inputting the cause & effects from the root cause analysis along with the corrective actions into the FMEA, it becomes a document that improves over time to help determine root cause effectiveness. It becomes the permanent record of past learning so that the process can continue to be refined and developed. FEMA's offer an effective means to visually illustrate the interaction of process variability that can lead to a rust event.

FMEA																		
Item	Operation	Failure Mode	Failure Effect	SEV	Cause	Prevention	OCC	Detection	DET	RPN	Recommend Action	Responsibility	Action Taken	SEV	OCC	DET	RPN
1	Finish ID Machining	Inadequate rust protection for 16 days of WIP	Rust	5	• Low coolant concentration	• Zimmark Alert Compliance	4	• Refractive Index	3	60	• Increase coolant concentration to target 9%	Zimmark	• Adjusted Zimmark Alert Compliance target range	5	3	3	45
2	Wash Station	Part Not Clean	Fail Millipore Test	4	• Low wash concentration	• Zimmark Alert Compliance	3	• Titration	3	36							0
				4	• Low pH	• Zimmark Alert Compliance	3	• pH Meter	3	36							0
				4	• High TDS Contamination	• Zimmark Alert Compliance • Weekly Sump clean outs	4	• Soluble	3	48	• Filtration system to reduce contamination occurrence	Widget Inc.	• Installed filtration system	5	3	3	45
				4	• High Tramp Oil Contamination	• Zimmark Alert Compliance • Weekly Sump clean outs	4	• Soluble	3	48	• Filtration system to reduce contamination occurrence	Widget Inc.	• Installed filtration system	5	3	3	45
				4	• Low Temperature	• Machine Controlled	2	• Thermometer	4	32							0
				4	• Low Exposure Time	• Work Instruction	4	• Visual Inspection	5	80							0

Stage -6- Rust Correction Verification

Verification Plan:

Corrective action verification is about ensuring that the process changes made are in fact delivering on the desired output. With the checks, balances and corrective actions now built into the manufacturing process, is it delivering the desired results?

Stage 2 in this process defined the current state, as well as the desired future state ie **"the widget must be free from rust upon arrival and maintain a 30 day rust free shelf life."**. In this example, the intent of the corrective actions made was to ensure that the facility is able to consistently deliver parts that are rust free and provide up to 30 days of rust free shelf life. This future state needs to exist, regardless of changes to variables that are outside of the plants control (ie temperature, relative humidity, etc.) while controlling and reacting to the variables that are being managed and maintained on a daily basis.

"What's measured improves" — Peter F. Drucker

Data Collection, Interpretation & Validation:

In the interest of reducing all forms of waste, data collection, Interpretation and validation needs to be easily incorporated into existing diagnostic tools. The tools to diagnose must be able to present relevant information together, to make timely interpretation easy and straight forward. By being able to easily cross reference process control parameters, with desired future state performance results, a facility is able to 1st validate and then work to optimise the process. Unless condition and effect can be easily correlated, it becomes difficult to tie cause and effect together, especially when the goal is to tightly control the process in order to minimize operating costs. "Over-corrective Action" often occurs, especially when the Cost of a rust event is significant. In an effort to avoid the event, often facilities build large process contingencies into the system to avoid the event, hurting profitability and masking the opportunity to optimise the process.

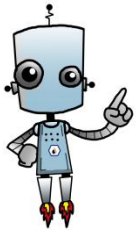
"Optimizing Processes is about building routines around measuring the factors that impact performance and then taking timely corrective action. " — Sargent Z

Sargent- Z

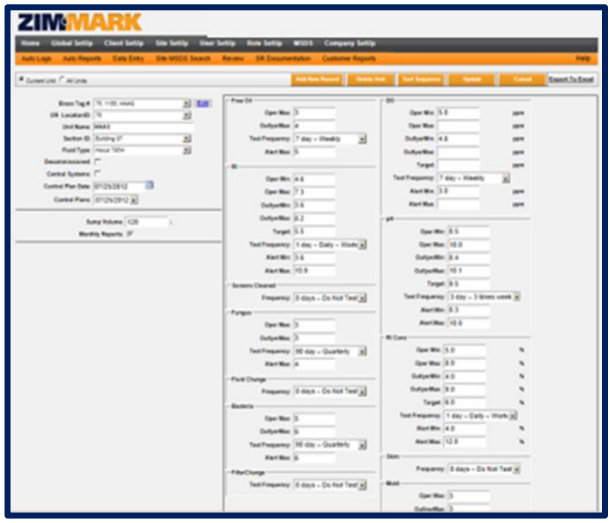
ZIMMARK
TECHNICAL PROCESS MANAGEMENT

Stage -7- Standardization & Rust Prevention

Standardizations Tools



- Control Plan
- Operator Work Instruction
- Training Programs
- Data Collection & Compliance programs
- Preventive Maintenance Systems



ZIMMARK GNU Coolant PM Schedule Report - Cln Out

Location ID	Brass Tag	Unit Name	Section Name	Fluid Name	Last Date	Frequency	Next Date	Days Over Due	% Days Over Due
14	378	Daewoo Vertical Machining Center	Building 87	Hocut 795H	01/09/2013	120 Days	05/09/2013	-104	
4	347	Daewoo Vertical Machining Center	Building 87	Hocut 795H	01/09/2013	120 Days	05/09/2013	-104	
5	335	Daewoo Vertical Machining Center	Building 87	Hocut 795H		120 Days			
6	345	Daewoo Vertical Machining Center	Building 87	Hocut 795H		120 Days			
7	339	Daewoo Vertical Machining Center	Building 87	Hocut 795H		120 Days			
8	379	Daewoo Vertical Machining Center	Building 87	Hocut 795H		120 Days			
9	342	Daewoo Vertical Machining Center	Building 87	Hocut 795H		120 Days			
10	343	Daewoo Vertical Machining Center	Building 87	Hocut 795H		120 Days			
11	439	Daewoo DMV-004	Building 87	Hocut 795H		120 Days			
12	440	Daewoo DMV-004	Building 87	Hocut 795H		120 Days			

Standardization & Prevention Tools:

What makes diagnosing rust events so difficult and potentially complex, is that the manufacturing process works well most of the time, its only when a couple of different variables cross thresholds at the same time does it create the conditions necessary for rust to occur. 99.9% of the time the process provides sufficient protection and therefore variables go unchecked as their interaction is not fully understood.

When properly executed, a rust investigation reveals some very important process variable interactions. For example understanding the relationship that exists between the grade of steel at a specific facility, local water quality, sump pH, temperature, humidity, fluid contamination levels, part cleanliness, dry time and the RP characteristics of the fluid in use can all impact the amount of time the part can be exposed to ambient conditions before rust occurs. Once a detailed understanding of these interactions has been developed the opportunity to take that learning to all the other related applications in the facility is an essential next step. When facilities are not monitoring and reacting to the variables that can lead to the formation of rust, it normally means that there is both significant risk of rust in other areas, as well as significant process waste. For example, often facilities move to aggressive PM based programs to address historical rust issues, where fluid is changed out and sent to waste on an aggressive schedule instead of letting sampling and analysis determine fluid condition and therefore manage rust risk in a much more cost effective manner.

By taking the lessons learned and rolling them out to the other operations within the facility, its possible to significantly reduce the risk of rust across the board, and significantly reduce the waste that creeps into any operation where true root cause is not known.

Problem Solving Tools & Services

If you find this rust problem solving guide is helpfully to you and your team and are interested in using some of the problem solving tools displayed in this publication, you can download our free problems solving tools at the links below. Additionally, if you are looking for more information and technically support in helping your team solve your rust problem click on the links below for more information.

- Process Map Tool
- Action Deck Template
- Cost of Poor Quality Template
- Rust Cause & Effect Diagram
- Rust 5 Why Template
- Root Cause Fluid Analysis, Testing & Verification
- Technical Process Parameter Review
- Rust Problem Solving Process Facilitation
- Head to Head Fluid Evaluation (using site conditions)

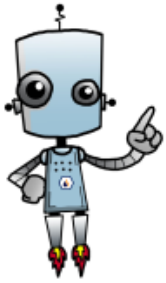
ZIMMARK
TECHNICAL PROCESS MANAGEMENT

The Team.....

Zerlock: Takes a completely unbiased assessment of the circumstances surrounding a rust event, Zerlock's approach to problem solving brings value by being able to investigate the situation with a wealth of specialised fluid related expertize, tools and process that the client does not typically maintain in-house. Focus: Problem Solver

Zeinstein: Takes the complex and makes it simple by looking at the problem from a different angle. Simplicity is the key to sustainability and Zeinstien's unique approach to finding and then optimizing the solution makes him an important part of the team, when you want the problem to stay solved. Focus: Elimination of waste.

Data: Accurately and consistently storing the data, making the data easily accessible together with the tools to correlate and trend the information found, makes Data an invaluable member of the team. You can only manage what you can measure. Data makes management possible and puts process optimization within reach



Sargent Z: Corrective action without the discipline of consistent execution causes companies to repeat the same mistakes over and over. **Sargent Z** is a highly trained, fully accountable soldier that follows orders to the letter every time. Working closely with Data, Sargent Z focus's on sustainability and keeping the process in control.

About us....

Our Belief & Core Business

Optimizing all aspects of your business is critical in today's world of global competition. Where most companies have business process well developed and excellent in-house expertise to control the variability of their product, there is still significant opportunity to improve the control around the supporting processes. Reducing variability and establishing robust process controls in those supporting systems is critical when **Total Cost Optimization** is the goal.

Since 1984, Zimmark has been providing on-site technical services that focus on eliminating industrial fluid condition as the root cause to any OEE or HS&E related issue. Using our extremely broad experience with various fluids, in various applications using varied fluid decontamination technologies, our core expertize and business process lets us help the manufacturing industry in their efforts to achieve the lowest **Total Cost**.

Zimmark's commitment and promise to all our clients is to continue to work to reduce the total cost of manufacturing. **Total Cost** reduction is made up of three components:

1) **Process Control:** reducing variability in the factors that can negatively impact OEE, or create unmanaged compliance or HS&E Risk
2) **Problem Resolution:** If an issue does occur, then its critical that the true root cause is identified and sustainable corrective action be implemented. Mis-diagnosis, reacting without the right data or data misinterpretation can cost a facility significant time and expense without ever truly addressing the root cause.
3) **Continuous Improvement:** By systematically eliminating all the forms of waste that can exist in any manufacturing process, we assist our clients in their efforts to continuously drive costs down over time.

We sincerely hope you find this rust guide useful. We will continue to make tools to support this guide in our effort to help industry reduce their **Total Cost** of manufacturing, so please check back on a regular basis at:

Web: www.zimmark.com
Phone: 888-632-5410
Email: Zimmark@zimmark.com

ZIMMARK
TECHNICAL PROCESS MANAGEMENT