Implementing Effective PMI Programs

by John Bailey

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- BS Mechanical Engineering from Oklahoma State
- Professional Engineer and Project Management Professional involved in the refining, upstream, and manufacturing industries. Project involvement includes design, project engineering, mechanical integrity, process hazard analysis, project management consulting, and other opportunities.
- The inventor of the PMI patent for SGS and designed and developed the first version of the SGS MIMS.
- Designed various systems to improve efficiency and quality at SGS for various processes involving scanning, document management, and process optimization.

Overview

- Why perform PMI?
- PMI Program Goals
- Typical PMI approaches
- An Effective PMI System
- Conclusions

Why PMI?

Avoid catastrophic failure due to wrong alloy in service

- Personnel safety
- Facilities damage
- Community perception
- LPO due to unscheduled outages

July 2005 USGC Resid Hydrocracker

It only takes 1 off-spec component to cause a loss of containment and cause a catastrophic failure

Why PMI?

PMI is the key to preventing catastrophic failure due to the wrong material in service

- PMI will identify hidden triggers of future accidents
- Each component in incorrect service represents a near miss
- PMI supports post-accident audits

July 2005 USGC Resid Hydrocracker

Why PMI?

Long service times of equipment or piping are not a good indicator of correct alloy usage

5 years in service (1984)

- Delayed Coker unit in Canada
- Maintenance item failed

16 years in service (late 1980's)

- Coker unit in Louisiana
- Original construction item failed

12 years in service (1994)

- Hydrocracker unit in US Gulf Coast
- Maintenance item failed

Source: Setterlund, R.B., "Refinery Piping Fires Resulting from Variations in Chemical Composition of Piping Materials," 2nd Int. Symp. Mech. Integrity of Process Piping, Houston, TX, 1996.

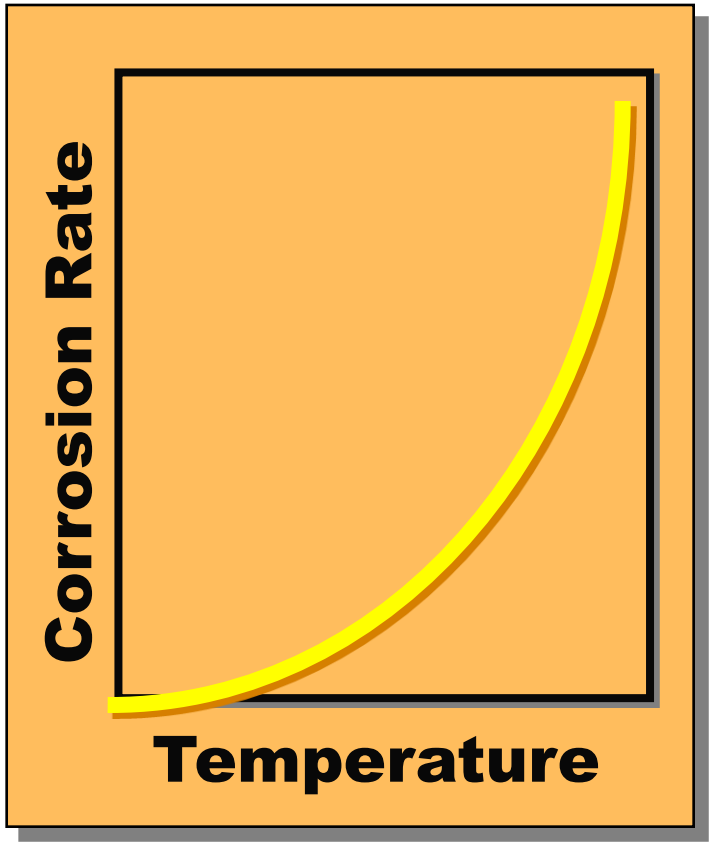
Why PMI?

Actual Refinery SGS PMI Results

	Components Measured	Non-conforming	% Non-conforming
Pipe	3950	300	8%
Valves	1675	175	10%
Fittings	7775	500	6%
Welds	9700	675	7%
Total	23,100	1650	7%

Why PMI?

- Impact of Refinery Crude Slates on Corrosion
- Lower cost, higher sulfur content crudes
- More aggressive operating conditions



Effective PMI Program Goals

- Identify all critical components
- Analyze all critical components
- Manage remediation activities
- Support potential audits
- Value

Typical PMI Approaches

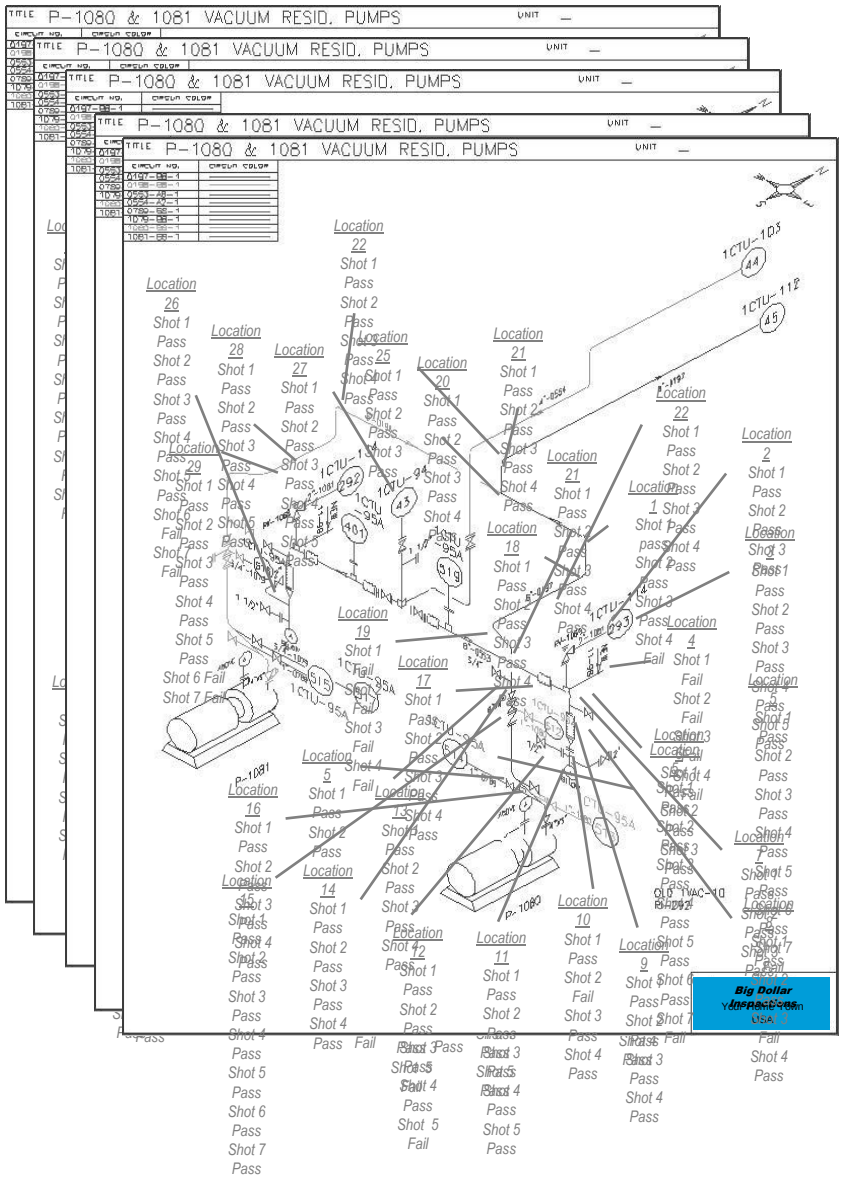
Approach 1 – Fully Manual

- **Line drawings with hand written data indicating results from each analysis**
- **Pass/Fail or brief analysis recorded on each component in drawing**
- **Multiple copies of drawings to handle data quantity**

Approach 2 – Spreadsheet based data

- **Line drawings with hand written data indicating results from each analysis**
- **Shot ID's referenced on drawing match Excel spreadsheets produced by analyzer**
- **Multiple copies of drawings to handle data quantity**

Typical PMI Approach



- Manual identification of components
- Data recorded on the drawings
- Up to 600 analyses per drawing
- Multiple copies of drawings required

Challenges of Typical Approaches

Identifying all critical components

Ensuring analysis of all critical components

Categorizing discrepancies for corrective action

Managing corrective actions

Determining impact of changing operating conditions

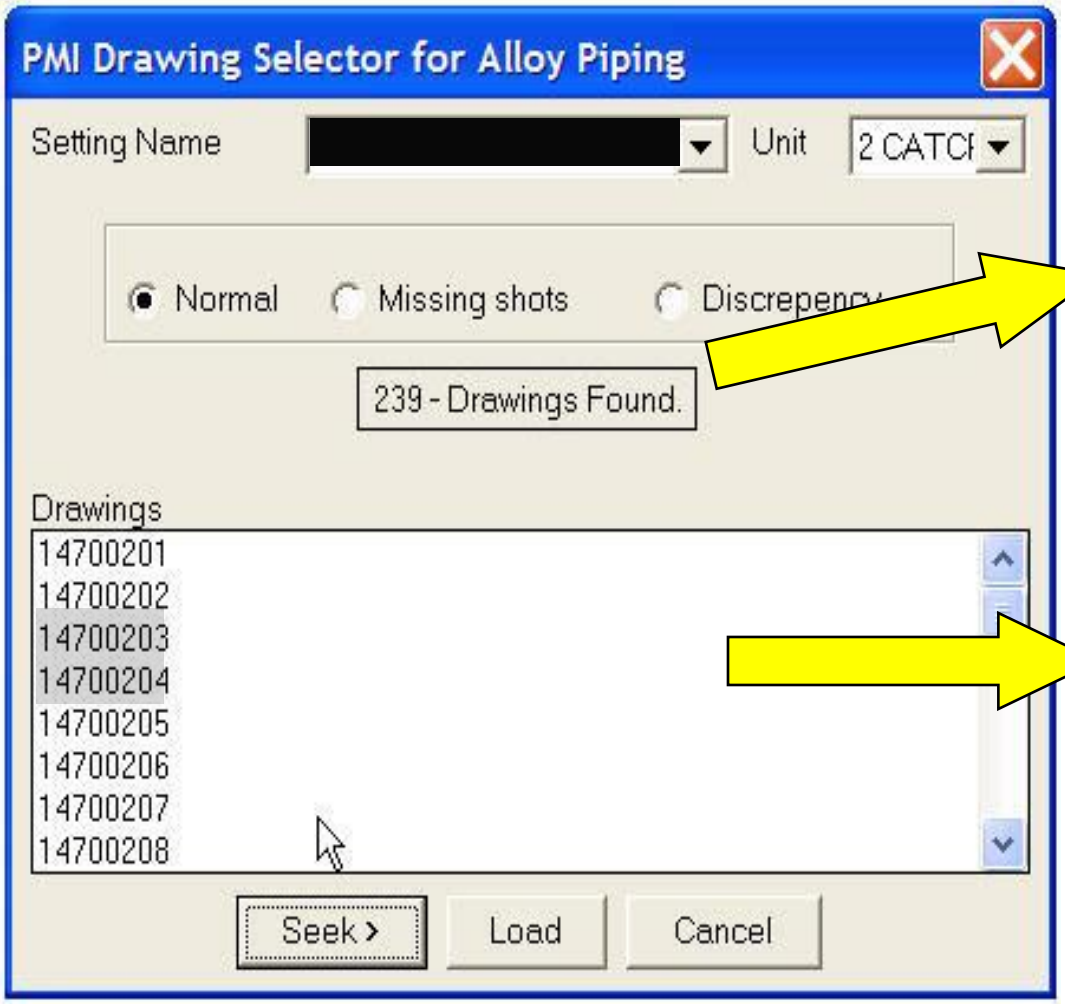
Improved PMI System Advantages

- ✓ Identifying all critical components
- ✓ Ensuring analysis of all critical components
- ✓ Categorizing discrepancies for corrective action
- ✓ Managing corrective actions
- ✓ Determining impact of changing operating conditions
- ✓ Robust for audit
- ✓ Value

Identifying all critical components

- Identify critical alloy systems on P&ID’s
- Locate all drawings having critical systems
- Identify and locate spec breaks on drawings
- Detailing all components requiring analysis on drawings

Identifying all critical components



Automatically locates all drawings containing alloy materials

Allows selecting and editing of drawings for review

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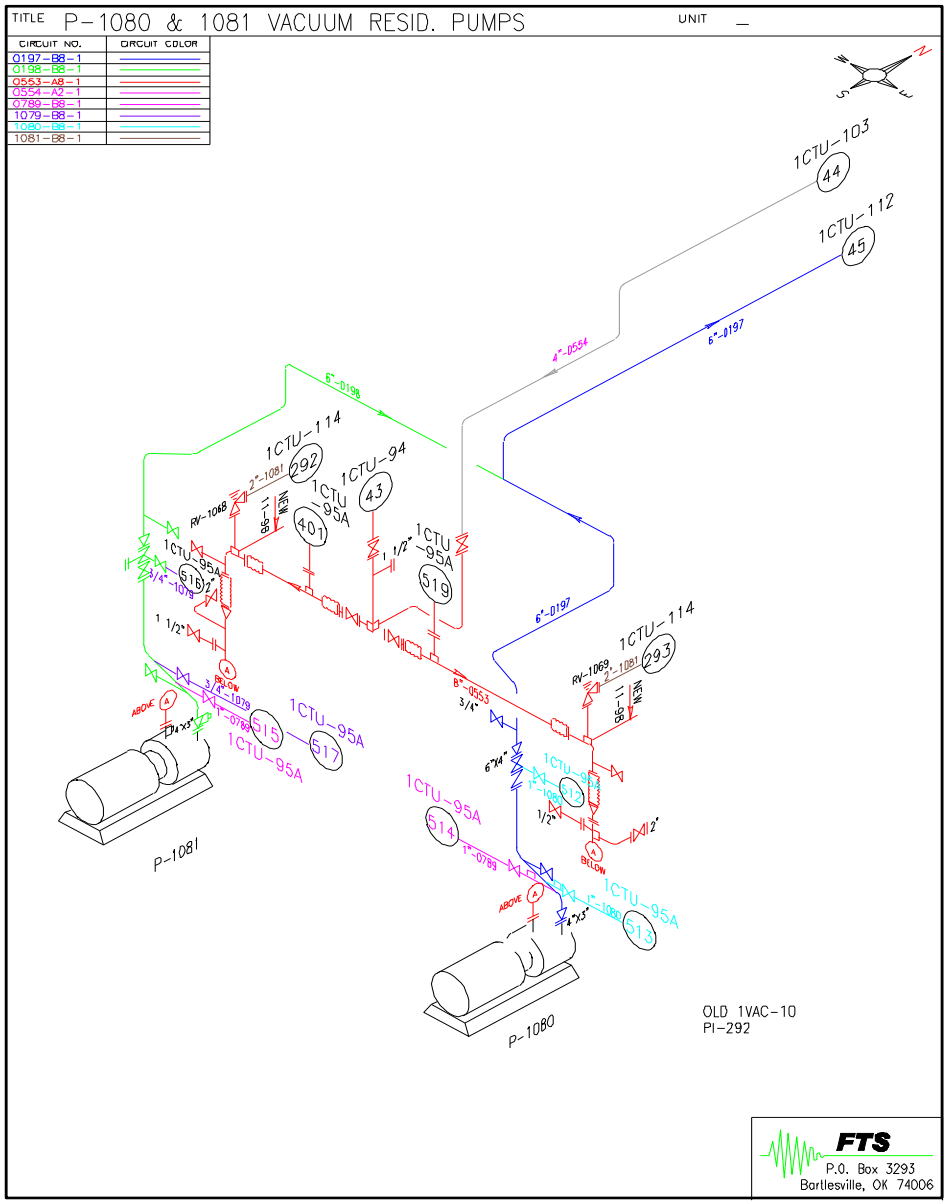
Identifying all critical components

System

- Accommodates both Block style and Single line ISO drawings



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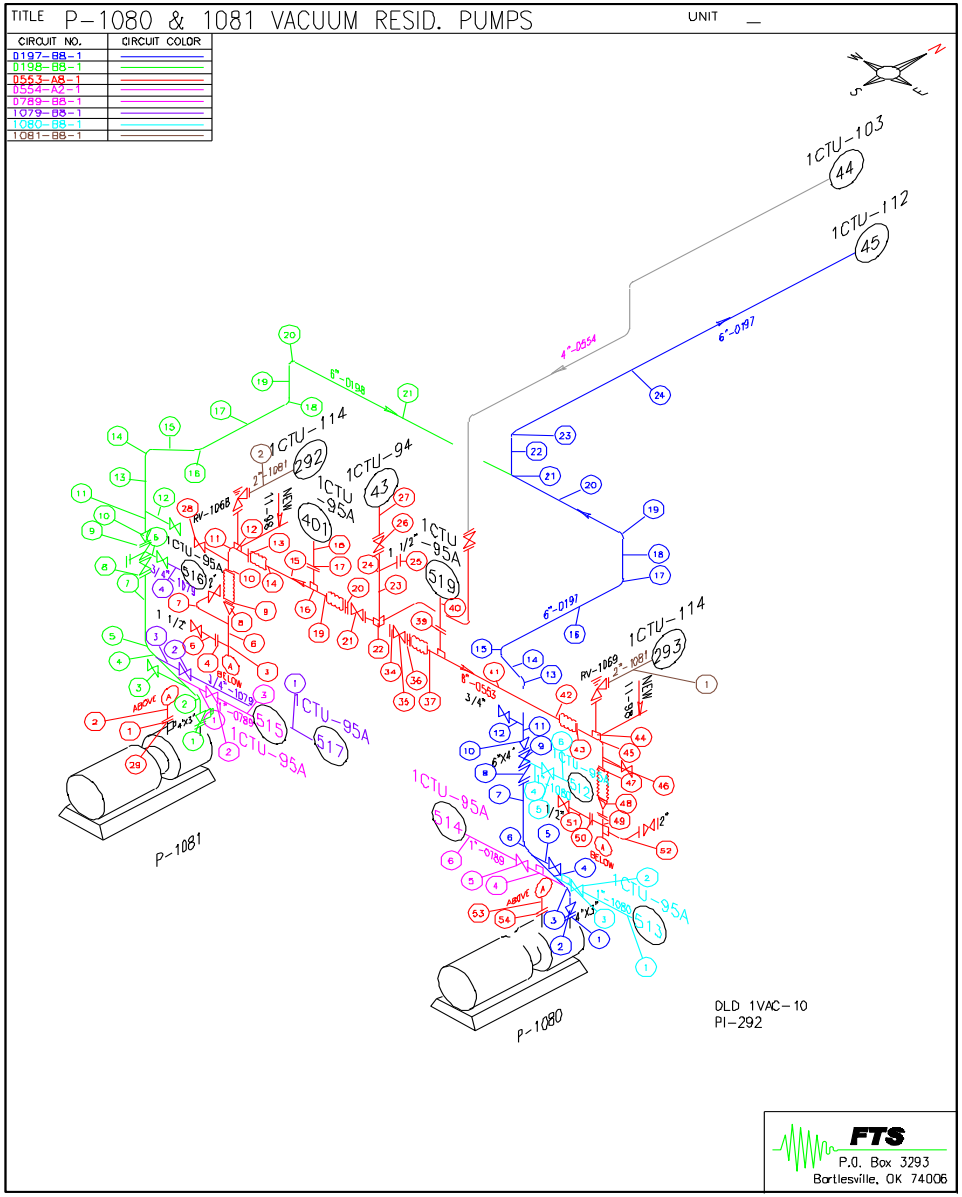
Identifying all critical components

Process Unit

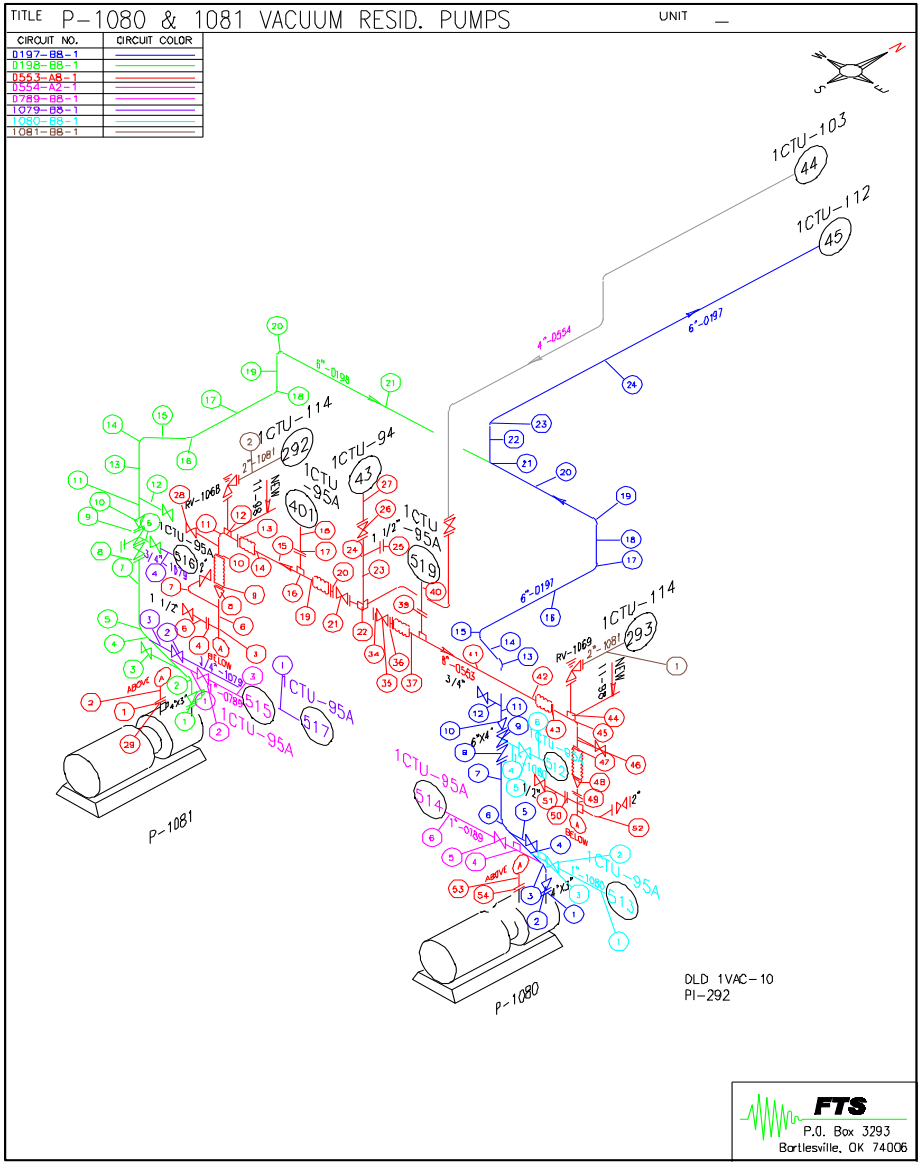
- Up to 60 drawings
- Up to 600 shots per drawing
- >10,000 Shots



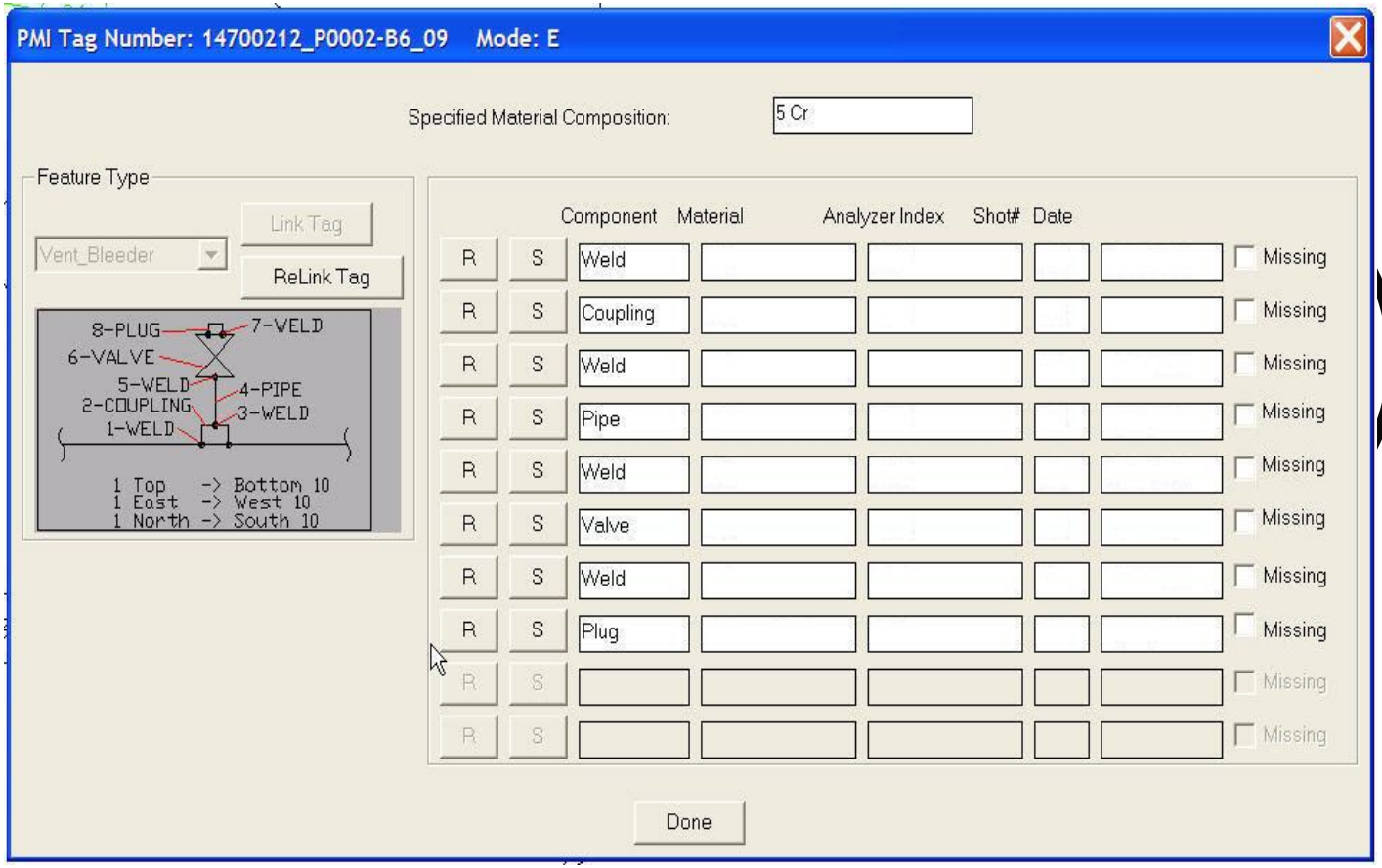
Ensuring analysis of all critical components

Each "Bubble"

- Identifies critical component location
- Represents multiple data points



Ensure all critical component analysis



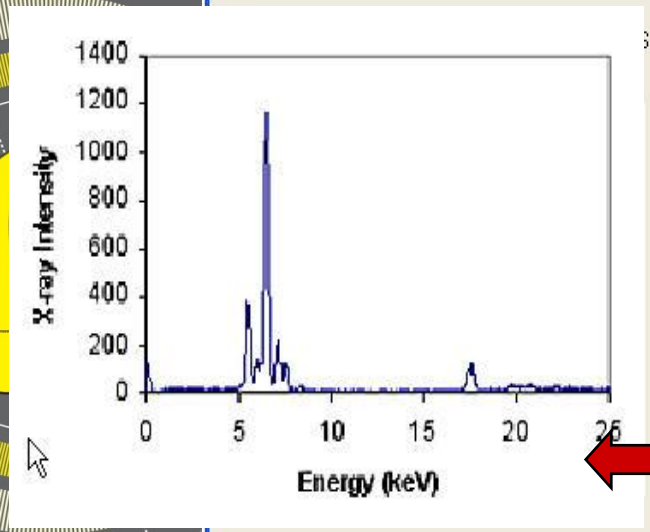
Ensure all critical component analysis

Positive Material Identification

Retest Inspection Form for Non Matching materials

PMI Tag Number	Spec. Material Feature	Sub	Component	Innov-X Shot
14700212_P0002-B6_09_4	5 Cr	Vent_Bleeder	4	Pipe	
4749	Matchl: 5 Cr	Pass_Fail: 5 Cr		
	Cr: 5.09	Date: 01/31/2005		
	Fe: 94.91			
14700212_P0002-B6_09_5			5	Weld	
4750	Matchl: 5 Cr	Pass_Fail: 5 Cr		
	Cr: 4.25	Date: 01/31/2005		
	Fe: 95.75			
14700212_P0002-B6_09_6			6	Valve	
4751	Matchl: 5 Cr	Pass_Fail: 5 Cr		
	Cr: 4.52	Date: 01/31/2005		
	Fe: 95.48			
14700212_P0002-B6_09_8			8	Plug	
4753	Matchl: Carbon	Pass_Fail: Carbon Steel		
	Cr: ND	Date: 01/31/2005		
	Fe: 98.9			

Critical Component Data Availability



PMI Tag Number: 14700212_P0002-B6_09 Mode: E

Specified Material Composition: 5 Cr

		Component	Material	Analyzer Index	Shot#	Date	
R	S	Weld	5 Cr	2556	180	01/31/2005	Missing

PMI Tag Number: 14700212_P0002-B6_09 Mode: E

Innov-X analyzer detail for PMI tag number: 4753

InnovX Match1: Carbon Steel | Innovx Pass/Fail: Carbon Steel | Temperature: 0.0

Shot Number: 187 | Name: Analyzer 2 | ID: Analytical | Shot Duration: 6.54 | Date: 01/31/2005

Element Analysis

Titanium	Vanadium	Chromium	Manganese
Content:	Content:	Content:	Content: 1.1
Prec. ±:	Prec. ±:	Prec. ±:	Prec. ±: 0.14

Iron	Cobalt	Nickel	Copper
Content: 98.9	Content:	Content:	Content:
Prec. ±: 0.87	Prec. ±:	Prec. ±:	Prec. ±:

Zinc	Tungsten	Niobium	Molybdenum
Content:	Content:	Content:	Content:
Prec. ±:	Prec. ±:	Prec. ±:	Prec. ±:

OK

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Categorizing Discrepancies

TA / PTA	PMI_tag	etype	component	sub_tag	eq_circ_id	comp_tag	Spec_mat	Pass_Fail	Match1	Temp	RT	UT	Date	Pass_Fail_Standard
AOK	_P0010-	Flange	Flange	2	B8-PIPE	14701013_P0010-B8_40_2	9 Cr	Carbon Steel	Steel				01/20/2005	
AOK	_P0010-	Flange	Flange	4	B8-PIPE	14701013_P0010-B8_37_4	9 Cr	316	316				01/20/2005	
AOK	_P0010-	Flange	Weld	5	B8-PIPE	14701013_P0010-B8_37_5	9 Cr	316	316				01/20/2005	
RPL	_P0010-	Plug	Plug	4	B8-PIPE	14701013_P0010-B8_38_4	9 Cr	NO MATCH	MATCH				01/20/2005	Zinc Coating
RPL	_P0003-	Vent_Bleeder	Plug	8	B6-PIPE	14700301_P0003-B6_50_8	5 Cr	No Shot	No Shot				02/02/2005	No Access - Hot Area
AOK	_P0002-	Weldolet	Weld	1	B6-PIPE	14700202_P0002-B6_11_1	5 Cr	7 Cr	7 Cr				02/03/2005	
AOK	_P0002-	Weldolet	Olet	2	B6-PIPE	14700202_P0002-B6_11_2	5 Cr	7 Cr	7 Cr				02/03/2005	
AOK	_P0002-	Weldolet	Weld	3	B6-PIPE	14700202_P0002-B6_11_3	5 Cr	7 Cr	7 Cr				02/03/2005	
*	_P0002-	Weld Flange	Weld	1	B6-PIPE	14700202_P0002-B6_01_1	5 Cr	Carbon Steel	Steel				02/03/2005	
RTM	_P0002-	Weld Flange	Flange	2	B6-PIPE	14700202_P0002-B6_01_2	5 Cr	Carbon Steel	Steel				02/03/2005	
RTM	_P0003-	Valve Flanged	Weld	1	B6-PIPE	14700313_P0003-B6_11_1	5 Cr	No Shot	No Shot				01/31/2005	No Access to Weld
RTM	_P0003-	Valve Flanged	Weld	7	B6-PIPE	14700313_P0003-B6_11_7	5 Cr	No Shot	No Shot				01/31/2005	No Access to Weld
RTM	_P0002-	Flange	Weld	1	B6-PIPE	14700203_P0002-B6_51_1	5 Cr	Carbon Steel	Steel				02/02/2005	

AOK	Item is OK of current operating conditions, and line should be reclassified
RTM	Item requires RT or other monitoring
RPL	Item is identified for replacement
* ENGR	Item needs engineering review of the analysis due to contamination, vibration, etc.

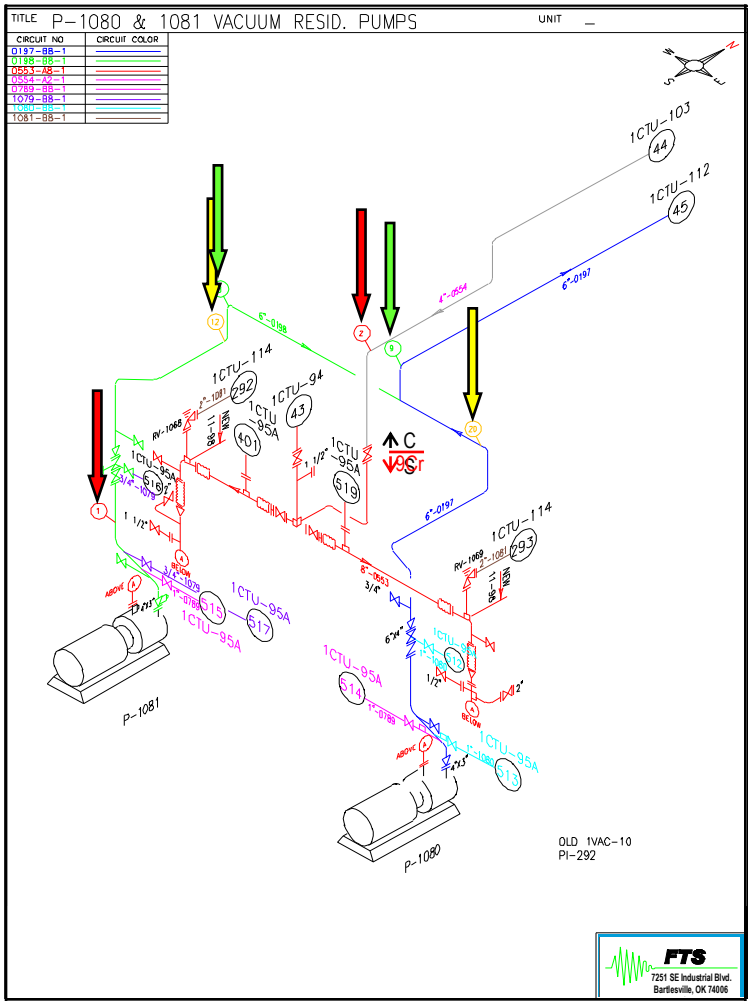
Reports can be easily produced sorting on any of the criteria in the database

Categorizing Discrepancies

Evaluate non-conforming components for actual requirements in service

- Replace components where required
- Monitor where necessary
- Reclassify circuits where possible

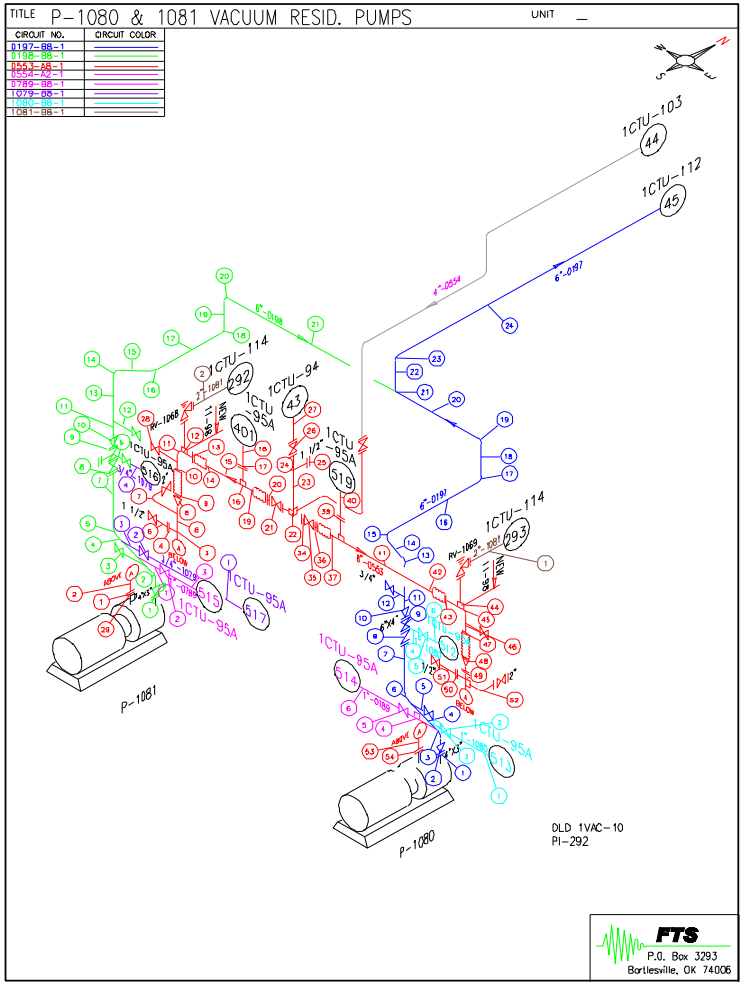
The program's ability to provide comprehensive reports and demonstrate unequalled data integrity illustrates robustness for audit



Categorizing Discrepancies

Typical work processes do not adequately address the amount and complexity of the data.

The improved solution exceeds capacity of conventional approaches in both data accuracy and depth of information.



Categorizing Discrepancies

Analyze components for suitability of operations with:

- More aggressive feeds
- Increased throughput
- Operating Pressure or Temperature changes

Can identify individual components which bottleneck refinery processes

Managing corrective actions

Interactive System

- Refreshed with reports from field
- Reconciliation of completed work is documented

Robustness for Audit

Summary of initial findings

Documentation of resolution of discrepancies

Current PMI status vs. original

Readily accessible details

Improved Program Value

Improved report validity

Improved data accessibility

Automation of report generation

Adjusts to changing design or operating requirements

Benefits transfer to other processes

Cost Effective

Cost Effective

Improved efficiency in:

- Field data collection
- Data entry
- Report generation

Cost Effective

	Components Measured	Non-conforming	% Non-conforming
Pipe	3[illegible]		
Valves	1[illegible]		
		500	6%
		675	7%
Total	23,100	1650	3%

Over 900 components that did not need to be replaced

700 components subject to failure in their current service

Achieves PMI Program Goals

- ✓ Identifying all critical components
- ✓ Ensuring analysis of all critical components
- ✓ Categorizing discrepancies for corrective action
- ✓ Managing corrective actions
- ✓ Determining impact of changing operating conditions
- ✓ Robust for audit
- ✓ Value

Conclusions

It is of utmost importance to maximize the benefits of the PMI process utilized

- Identify all components subject to failure in current service
- Support replacement of only the components requiring it
- Enable more aggressive operation
- Provide options to debottleneck plants
- Robust to support audits

Contributors

- Research & Process Development
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  - Butch Findley
- Presentation & Abstract Development
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Questions ???

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