A Problem Solving Principle Based System
Implemented at Sandia National Laboratories

Sandia National Laboratories

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Abstract

The Responsive Neutron Generator Product Deployment Center at Sandia National Laboratories believes in continuous improvement as the basis for how we do work. We have recently been looking for ways to increase the rate of improvement & reduce waste as well as to have better venues for growing our people in important competencies and skills. In our assessment of how to be better prepared for a future with increasing diversity of products and hence increasing diversity of problems and knowledge gaps, we identified "problem solving" as an area for further improvement. Interviews of our staff and evaluation of our critical metrics confirmed this assessment. Using the Toyota approach to problem solving and Lean-Six Sigma principles we established and implemented a Problem Solving Principle Based System using a methodology that in addition to problem solving skills, enables us to further grow our people in their analytical, mentoring, leadership and communication skills.

Outline

- **Why did we institute a Problem Solving Principle Based system?**
- **What is the Problem Solving PBS?**
- **What are our expectations?**
- **What was our Implementation Strategy?**
- **Where are we now?**
- **Lessons Learned**

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Why We Instituted a Problem Solving Principle Based System?

- Problem Solving is part of Lean, but has been a gap in our Center.

- Benchmark to Toyota to understand our gap.

- Staff member interviews used to validate management perception.

- Problem solving makes sense, it is the right thing to do.

What was the State of Problem Solving in our Center

- **Interviewed 31 MOWs from Center 2700 and its partners.**

- **Themes from problem solving interviews:**

  - Shotgun approach with temporary solutions
  - No follow-through
  - No documentation
  - Problems come back
  - Not enough time and resources
  - Over reliance on experts
  - Over emphasis on quick results

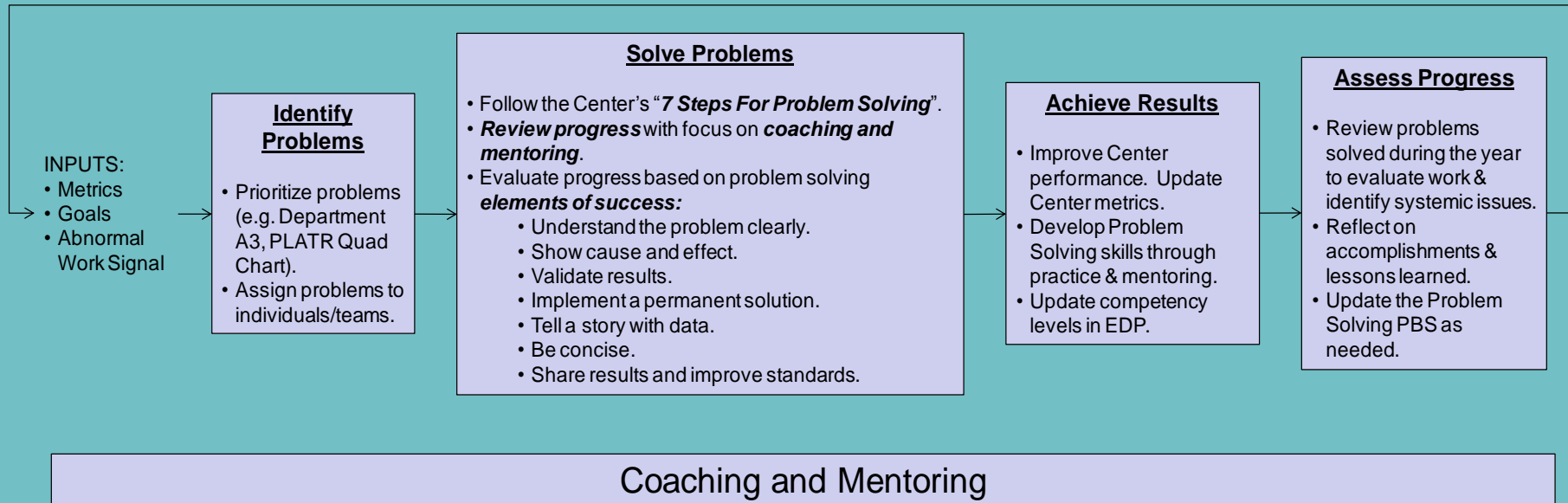Sandia National Laboratories

What is Problem Solving PBS?

- **It is a Principle Based System**
- **The system provides 7 steps for problem solving**
- **It will help develop the following skills:**
  - Problem solving
  - Effective communication
  - Mentoring & collaboration

- **Why do we need a common approach?**
  - Systematic & scientific way to improve the approach as we learn from using it.

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"Problem Solving" Principle Based System

PRINCIPLES

- Problems are a gap from a standard or a lack of a standard.
- Work has to flow and abnormal conditions must be recognized.
- Problems must be prioritized with respect to metric goals and resources.

- We need to enable people development and build a problem solving culture.
- Problems will be solved once and for all because of rigorous root cause, peer review, validation, and integrity.
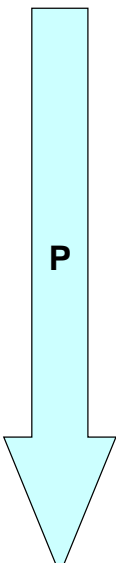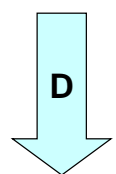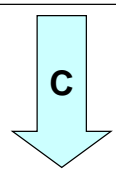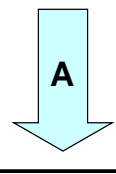
SYSTEM

INPUTS:
- Metrics
- Goals
- Abnormal Work Signal

Identify Problems

- Prioritize problems (e.g. Department A3, PLATR Quad Chart).
- Assign problems to individuals/teams.

Solve Problems

- Follow the Center's "*7 Steps For Problem Solving*".
- *Review progress* with focus on *coaching and mentoring*.
- Evaluate progress based on problem solving *elements of success:*
  - Understand the problem clearly.
  - Show cause and effect.
  - Validate results.
  - Implement a permanent solution.
  - Tell a story with data.
  - Be concise.
  - Share results and improve standards.

Achieve Results

- Improve Center performance. Update Center metrics.
- Develop Problem Solving skills through practice & mentoring.
- Update competency levels in EDP.

Assess Progress

- Review problems solved during the year to evaluate work & identify systemic issues.
- Reflect on accomplishments & lessons learned.
- Update the Problem Solving PBS as needed.

Coaching and Mentoring

TOOLS

7 QC Tools (cause & effect diagram, control charts, histograms, pareto charts, scatter diagrams, run charts, check sheets), 5 Why's, Apollo RCA, Kepner Tregoe (Decision Analysis, Problem Solving), Kaizen, Design Of Experiments, Issue Trees, Affinity Diagrams, Probability Tree Diagrams, etc…

7 Steps For Problem Solving

PDCA	Step	Purpose	Details
P	**1. Background**	Provide context & alignment.	• Provide historical data & context. • Keep it relevant, recent, and simple. • Describe why the problem is a priority and what goal does it aligns to. • Describe the current situation (knowing there's something wrong).
	2. Problem Definition	Understanding & breaking down the problem.	• Compare to standard & identify the gap. • Focus the problem (process flows, trends, and pareto charts are helpful tools). • Quantify the gap (know what's wrong). • Clearly define the problem statement.
	3. Goals	Establish what you are trying to achieve.	• Set SMART (Specific, Measurable, Attainable, Relevant, Timely) goals. • Don't write goals in action item language or as steps along the way.
	4. Analysis & Action Items	Perform causal analysis.	• Explore and explain why the gap exists. Can use any tool that is appropriate to analyze the problem. • Identify action items needed to show cause and effect (what, who, when, results). • Demonstrate cause and effect.
D	**5. Countermeasures**	Develop, select, prioritize, and implement countermeasures.	• Develop multiple countermeasure options. • Critically evaluate countermeasure options and determine which ones to implement. • Identify how the check will be done. • Develop implementation plan: Identify what to do, by whom, and by when. • Implement countermeasure(s).
C	**6. Check**	Verify that countermeasures have been effective at eliminating the root cause.	• Evaluate effectiveness (or not) of each countermeasure (individually if possible). • Document countermeasure results.
A	**7. Standardize and Follow Through**	Make the solution permanent & share.	• Standardize the countermeasure (make it permanent). Include actions needed to sustain and control (it can't be dependent on you, it has to be part of the system). • Remove "temporary countermeasures" that were implemented earlier on to mitigate risks. • Share lessons learned with appropriate people.

8   ◇ Peer review and/or management approval required before moving to next step.

NOTE: Iterations within the steps are acceptable.

Key Elements

Mentoring, Teaming, communication are key

- Don't solve the problem alone.

- Problem solver, manager, and mentor are the core of the Problem Solving PBS.

- Goal is to solve the problem and develop problem solving, mentoring, presentation and communication skills.

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Key Elements

Manager

- Primary role is to *drive* the problem solving team – Setting the *pace* **and** *priority***.**

- Manager *enables* team to be successful.

- Manager *guides* problem solvers to appropriate technical experts as necessary.

- Managers are *involved* in all stages of the problem solving effort.

- Managers *should integrate the expectations or overall goals*.

Key Elements

Mentor

- ***Mentors*** the team through the 7-step problem solving process.

- ***Develops*** managers and problem solvers to be future mentors.

Problem Solver Lead

- Is the ***lead*** in gathering information, identify team members and resources necessary to solve problem.

- Responsible to ***track and report*** on progress.

- Ensures thorough ***documentation and communication***.

- Must be ***presentation/communication ready*** at any time.

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Step 1 – Background

Provide context and alignment

<u>Key Points:</u>

• Keep it relevant and simple

• Evaluate the Historic data, and describe the current situation.

Step 1 – Background, Example 1
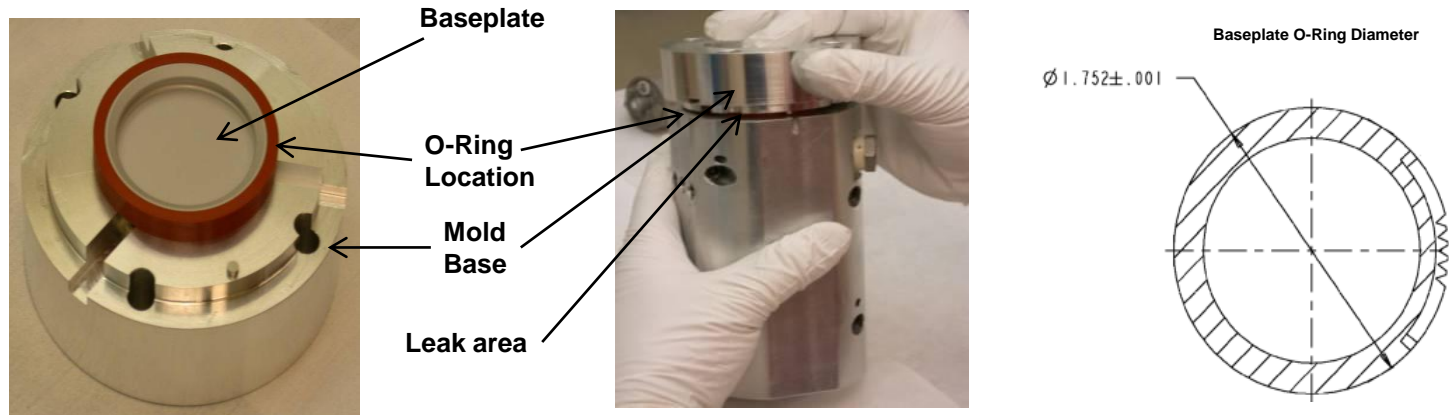
Problem Title: Loss of Bias

1. Background – Context

- Lot Acceptance Failures
  - 5 lot acceptance Product A LOB Failures to **PS** Requirement
  - 4 lot acceptance Product B LOB Failures to **PS** Requirement
  - All LOB failures **have met system requirements** when tested
  - Ability to meet long term reliability is not unknown/unpredictable

- Center Priority
  - Ship Quality Product to Meet Schedule

- What is preventing us from meeting the center priority (scope)?
  - LOB in Product A/B diagnostic testing
  - Root cause of LOB failure Mode is not determined
  - NG reliability may be at risk
  - Higher sampling rate will impact deliverables, cost, and the material supply chain.

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Step 1. Background

• 4 NGSA 's were lost during encapsulation due to O-ring failure

• each unit cost approx $70k a total of $280K.

•O-ring did not properly fit the base plate and caused encapsulation material leakage loosing both the NGSA unit and mold.

• Drawing requirement for o-ring diameter is 1.752 ±0.001 inches. There is no required incoming inspection at this time.
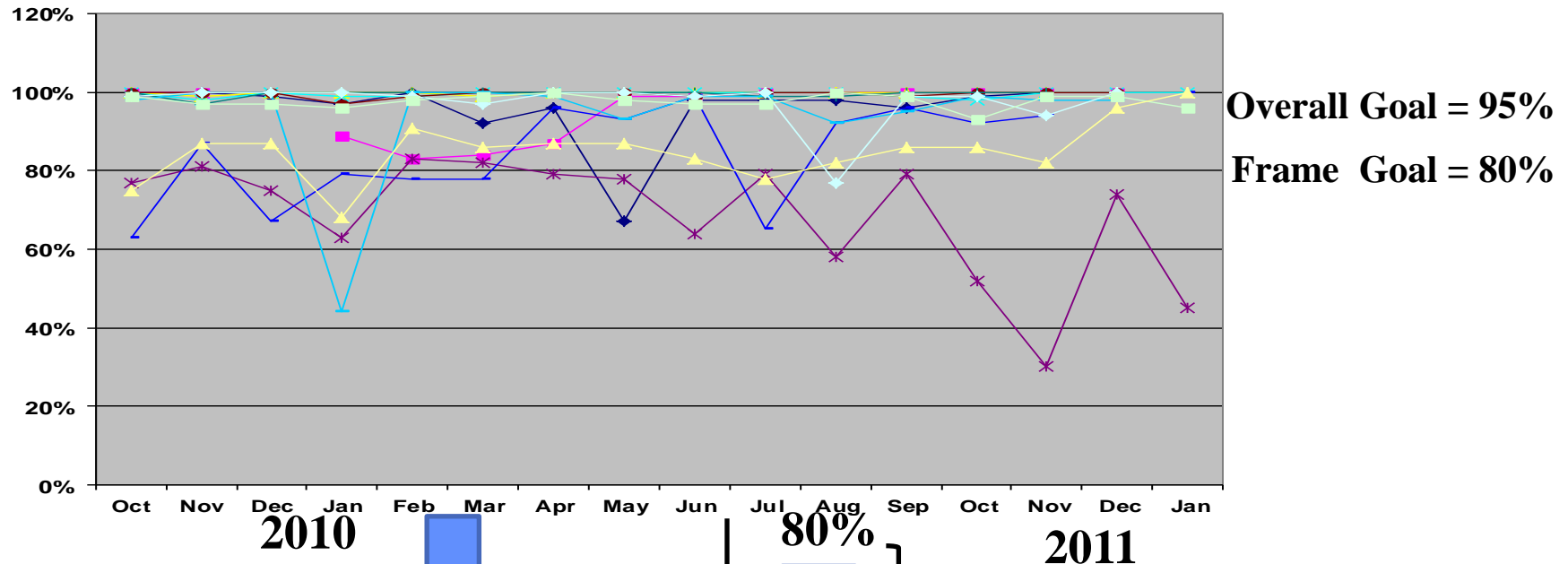

Baseplate

O-Ring Location

Mold Base

Leak area

Baseplate O-Ring Diameter

Ø1.752±.001

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Step 2 – Problem Definition

Understand and breakdown the problem and clearly state it

Key Points:

- Make the problem visual.

- Show data in charts/graphs.

- Concise and accurate statement

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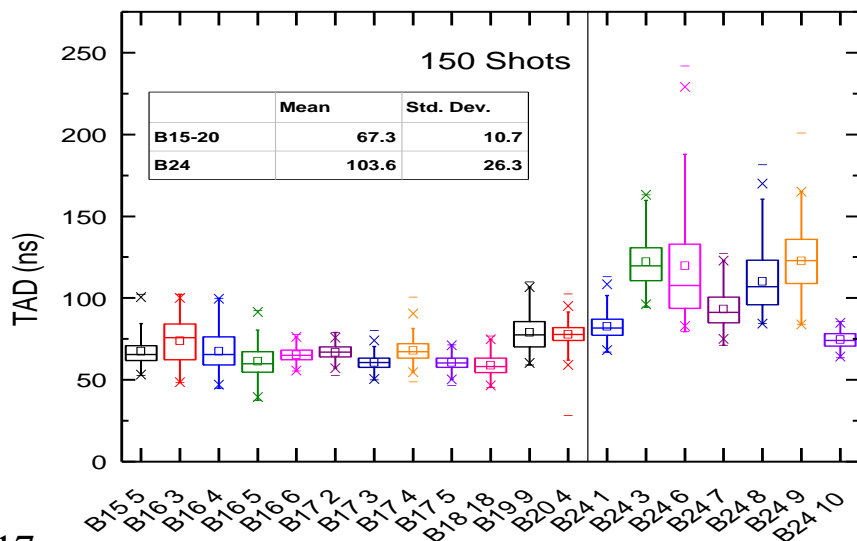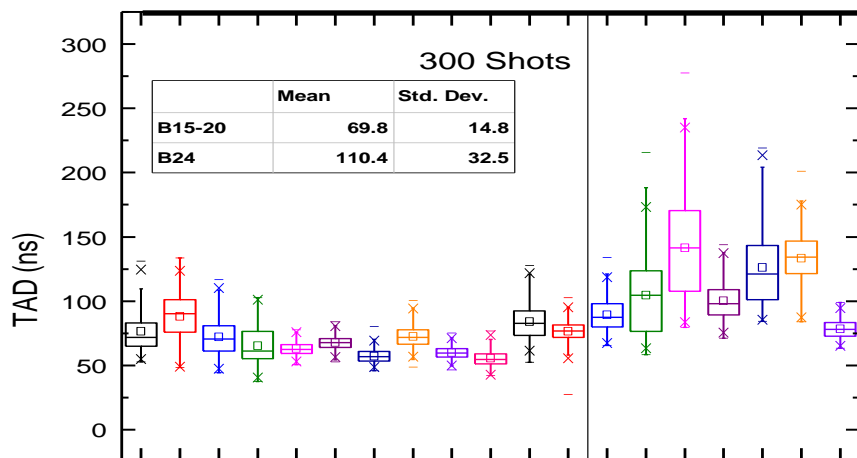
Step2 – Problem Definition, Example 1

Piece Part Yields

Step 2: Problem Definition

Problem: **Poco Sprytron TAD performance not meeting requirements.**

Target = ~70 ns average (15 ns std. dev.)

Actual = ~110 ns average (32 ns std. dev.)
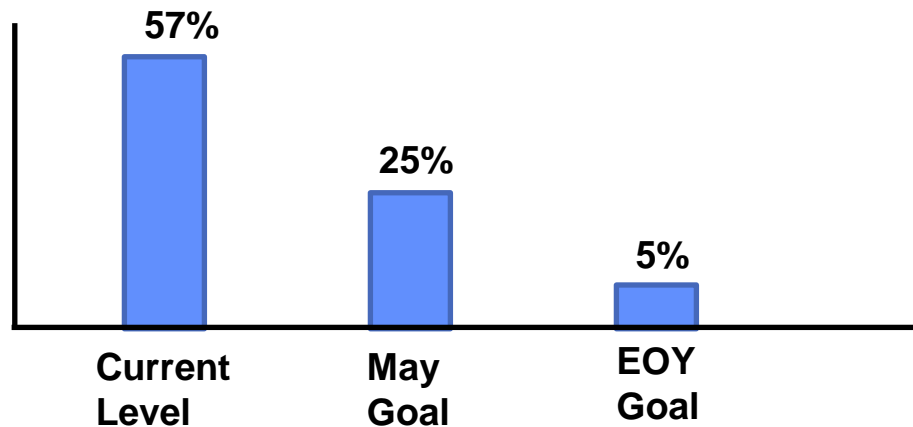
Gap = ~40 ns average

Step 3 – Goals

Establish what you are trying to achieve

<u>Key Points:</u>

- Closing a gap to the standard or

- Improving a standard.

Step 3 – Goals, Example 1

Goal: **Reduce frame scrap due to pullback from 57% to 25% by end of May and <5% by end of 2011**
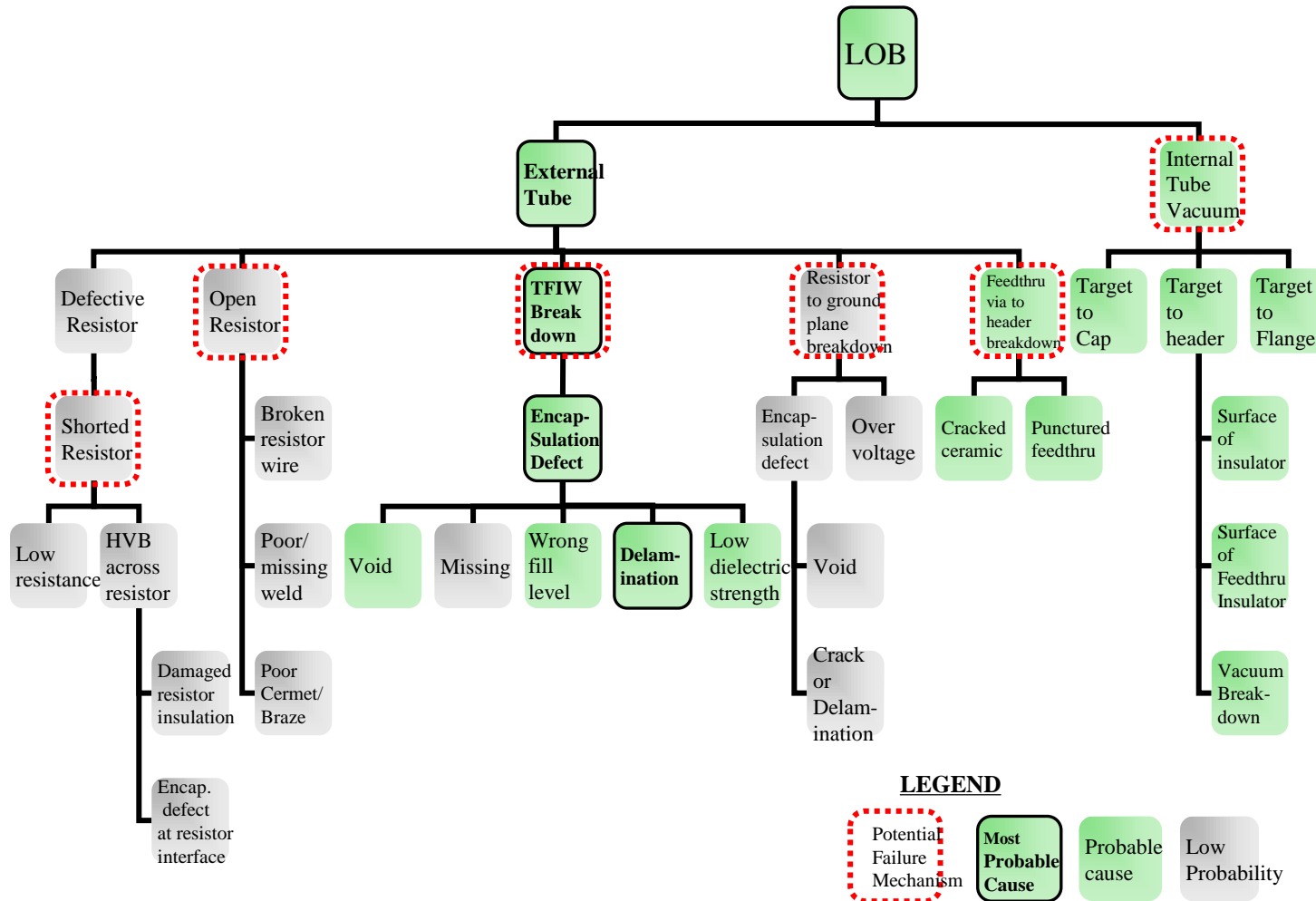
Step 4 – Analysis & Action Items

Perform causal analysis

Key Points:

- Analysis = Cause and Effect.

- Action items = how to complete the analysis.

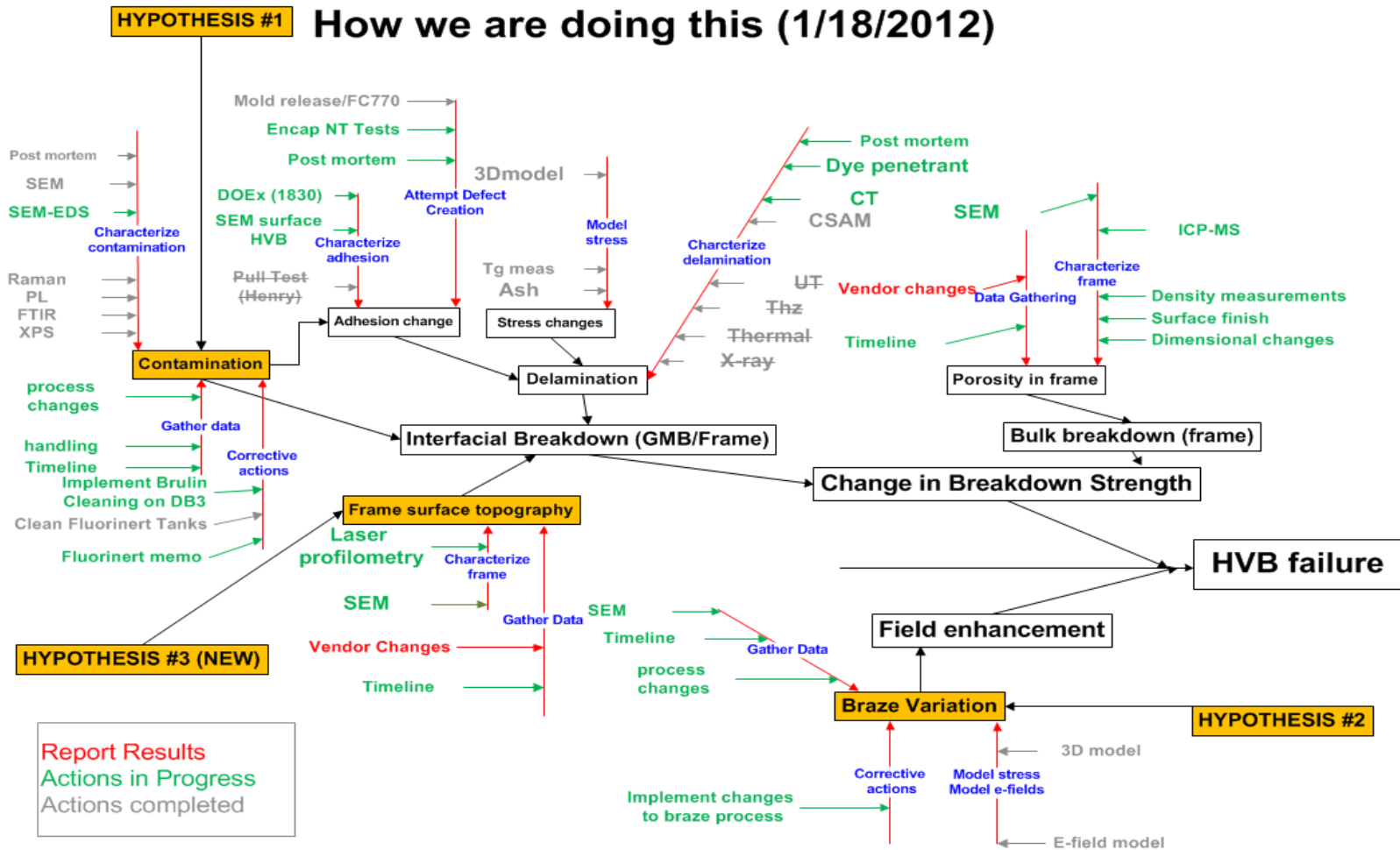Sandia National Laboratories

Step 4 – Analysis & Action Items, Example 1
Product Feature Fault Tree for LOBs in LFENG

Fishbone Diagram for EHVB Problem

Step 5 – Countermeasures

Develop, select, prioritize and implement countermeasures
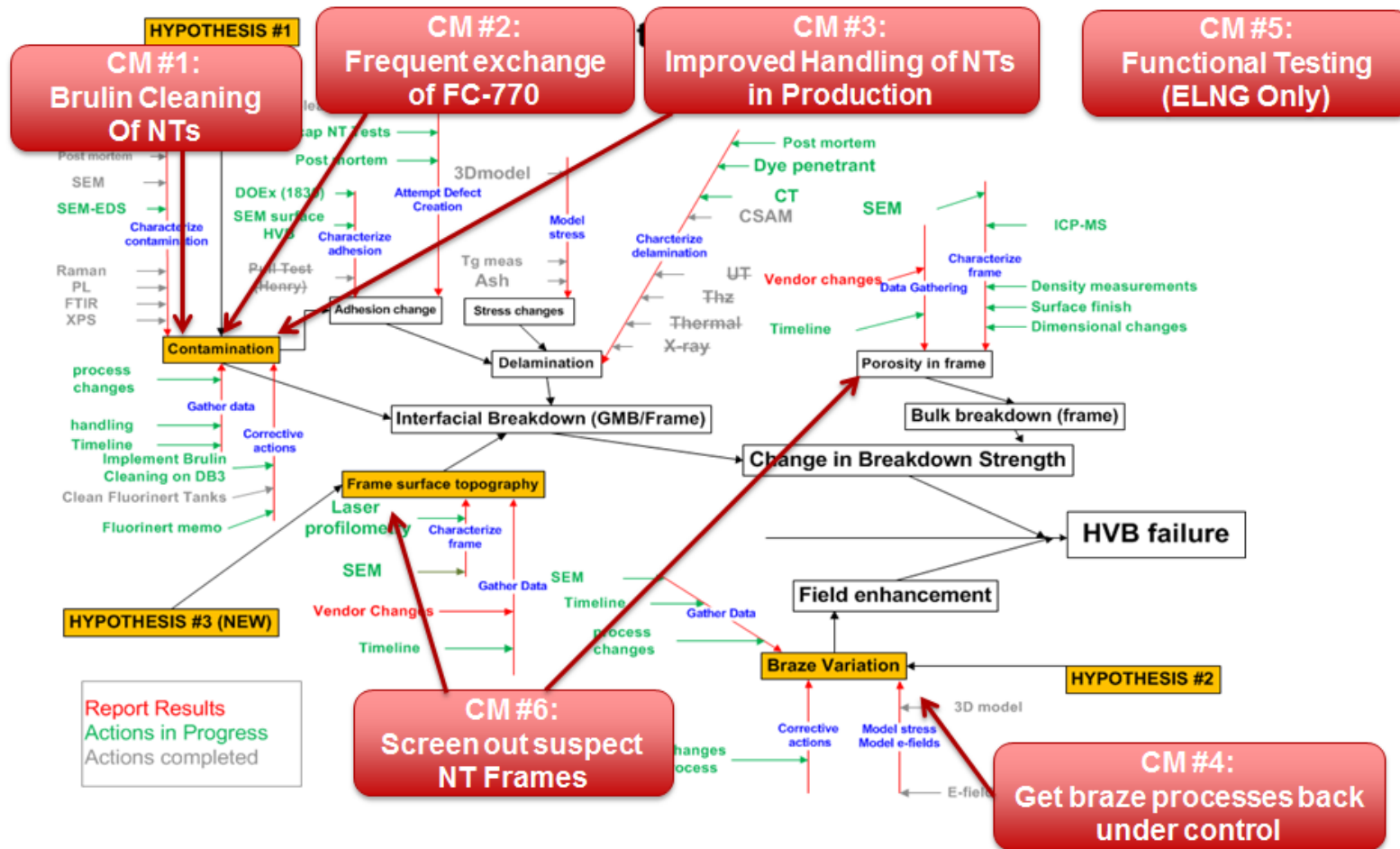
Key Points:

- Replace temporary countermeasures with permanent countermeasures if possible.

- May need to loop back in the process to analysis and actions.

Step 5 – Countermeasures, Example 1

Item #	Action	When	Who	Impact
1	Replace worn screens	Completed 4/7/11	Joseph/Cathy	MEDUIM
2	Using the same operator to eliminate one more variable	Completed 3/9/11	Joseph	HIGH
3	Qualify new screen printer to eliminate setup of small to large end of frame	July	Paul/Joseph	LOW
4	Keep screens of varying sizes on hand	Completed 4/20/11	Cathy/Bond & Stores	MEDIUM
5	Setup instructions revised	Completed mid June	Cathy/Joseph	MEDIUM
6a	Standardize inspections between operators	July	Cathy/Paul/Joseph	HIGH ROOT CAUSE
6b	Created JBS for using inspection scope	Completed June	Joe/Cathy/Ruth	HIGH
6c	Include criteria in WI for what constitutes a good frame	Completed July	Cathy/Joseph	HIGH

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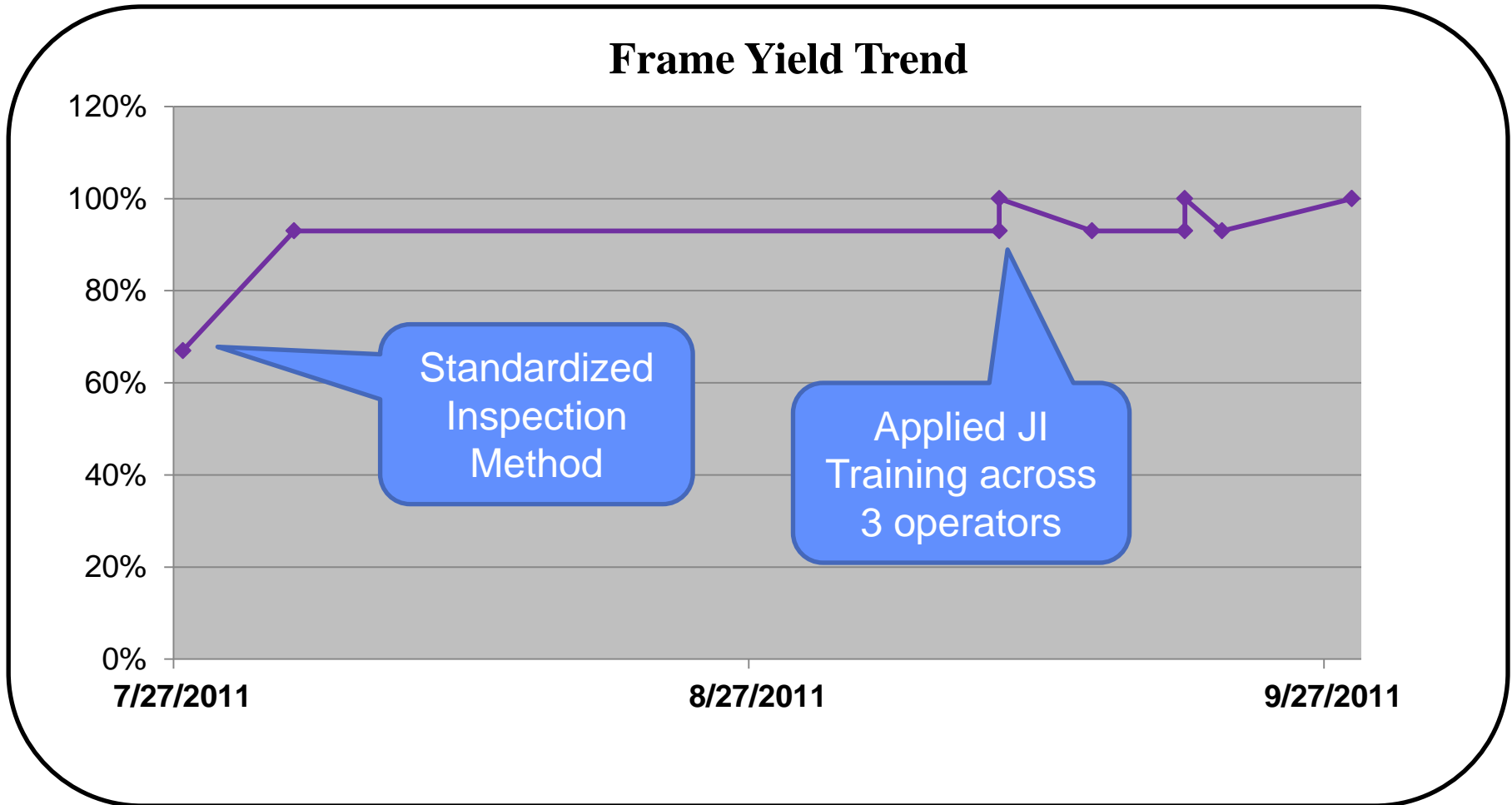# Step 5 – Countermeasures, Example 2

Step 6 – Check

Verify that countermeasures have been effective at eliminating the root cause

Key Points:

- Measure effectiveness.

- Check for unintended consequences.

- Evaluate both product and processes.

Step 6 – Check, Example 1

Frame Yield Trend

Step 7 – Standardize and Follow Through

Make the solution permanent and share

Key Points:

- Remove remaining temporary countermeasure.

- Replace with permanent fixes.

Step 7 - Standardized & Follow-through Example 1

Item	Resp.	Due Date
1. Update WI's to new inspection standard based upon findings	Joe & Cathy	Aug. 2011
2. Train new operator in inspection method	Joe	Sept. 2011
3. Re-train senior operators	Joe	Sept. 2011
4. Follow up on frame yield trends and pull back defects for certainty	Al & Joe	Through end of 2011

Management Team Expectations

- We will identify and prioritize meaningful problems

- Teams will stay engaged throughout the problem lifecycle

- We will mentor others and mentor each other

- **We will be patient**

- We will provide feedback

Implementation Strategy

- We started small with 5 problems in the Center.

- Initial problem solvers, their manager, and mentor were "trained" before starting the problem solving activity.

- The initial problem solvers were focused on the one problem and **had management and mentor support**.

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Implementation Strategy – cont'd

- The initial problem solvers will become mentors.

- The rest of the organization will be engaged as we mature the problem solving PBS & mentors.

- It will be **part of our <u>culture</u>.**

- We will gather and use feedback to improve.

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Where are we Now?

Less than one year after implementing this PS PBS (June 2011) – working 18 problems across the center

- Paraeto and management engagement to prioritize

- System of training, identifying, resourcing, mentoring

- Weekly communication to Management Team

- Monthly out briefs to other Problem Solving Teams to learn from each other.

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The Test

- Three big problems simultaneously descended upon the center.

  - Loss of Bias Problem for the Product A

  - External High Voltage Breakdown for Products B & C

  - Low Yields in Neutron Tubes for Products B & C

- Resource constraints

- Impacts on production and development activities

- Anxious customers

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PS Management Restructuring

- Resourcing multiple problem solving teams and supporting subject matter expertise

- Weekly out briefs

- Weekly progress reports

- Periodic Peer Reviews

- Biggest Problem Coordinating Council
  - To manage competing priorities

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Results

- **Loss of Bias Problem (detected June 2011):**

  – Identified 3 potential root causes; countermeasures developed accordingly for all 3

  – Product requalified in March 2012; key people redeployed

- **External HVB Problem (detected August 2011):**

  – Identified 3 potential root causes; countermeasures developed accordingly for 1 of 3. No EHVBs since.

  – Conducting corroborating experiments

- **NT Yield Problem (Detected 2011):**

  – Focused on two specific problem areas

  – Confirmed effective screening (i.e., quality integrity of units sold)

  – Yields improving

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Lessons Learned:
Critical Enablers (Must Haves)

- **Priority setting process**

- **Easy access to the data**

- **Access to SMEs and resources**

- **"Y in the Road" strategy**

- **Effective communication**

- **Mentoring, mentoring and mentoring**

- **Patience & trust**

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Other Problem Solving Endeavors

- 24 Problem solving teams have been identified and initiated in the center.

- 5 on hold

- 10 have resolved their problem and permanent solutions implemented

Problem Solving is now part of the Culture in our enterprise

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Contributions to the Success of the NG Enterprise

- Positive impact to Center metrics

- Culture change: people use 7 steps of problem solving as a standard way of doing work

- EDP competency increase in problem solving, mentoring, documentation, communication.

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Thank you.