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Root Cause Analysis

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Apollo Root Cause Analysis Program Institutionalization

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RCA PROGRAM

Scope

This document contains an overview of the necessary elements required for an effective and continuously improving Root Cause Analysis (RCA) program. It is important to recognize that needs and cultures vary from organization to organization. This results in variations of the appearance and structure of the final program, however the elements listed in this document will be necessary components for any program to have long standing success and to realize continuous improvement.

The necessary elements for any successful RCA program are:

- Program Goals
- Organizational Structure
- Deployment Time Frame
- Metrics, including threshold or “trigger” criteria
- Reporting
- Corrective Action Tracking
- Quality Control
- Continuous Improvement

Each of these elements will be discussed in detail throughout the document. Examples have been included to help illustrate how certain elements of the program will take shape.

Program Goals

The goals of the program should include what is expected from the RCA program; i.e., defect elimination, capacity improvement, cost reduction, safety improvement, complaint resolution, system reliability improvement, etc, or some combination of all of these. Once you determine the desired areas for improvement, the structure and roles for your RCA program will become clearer.

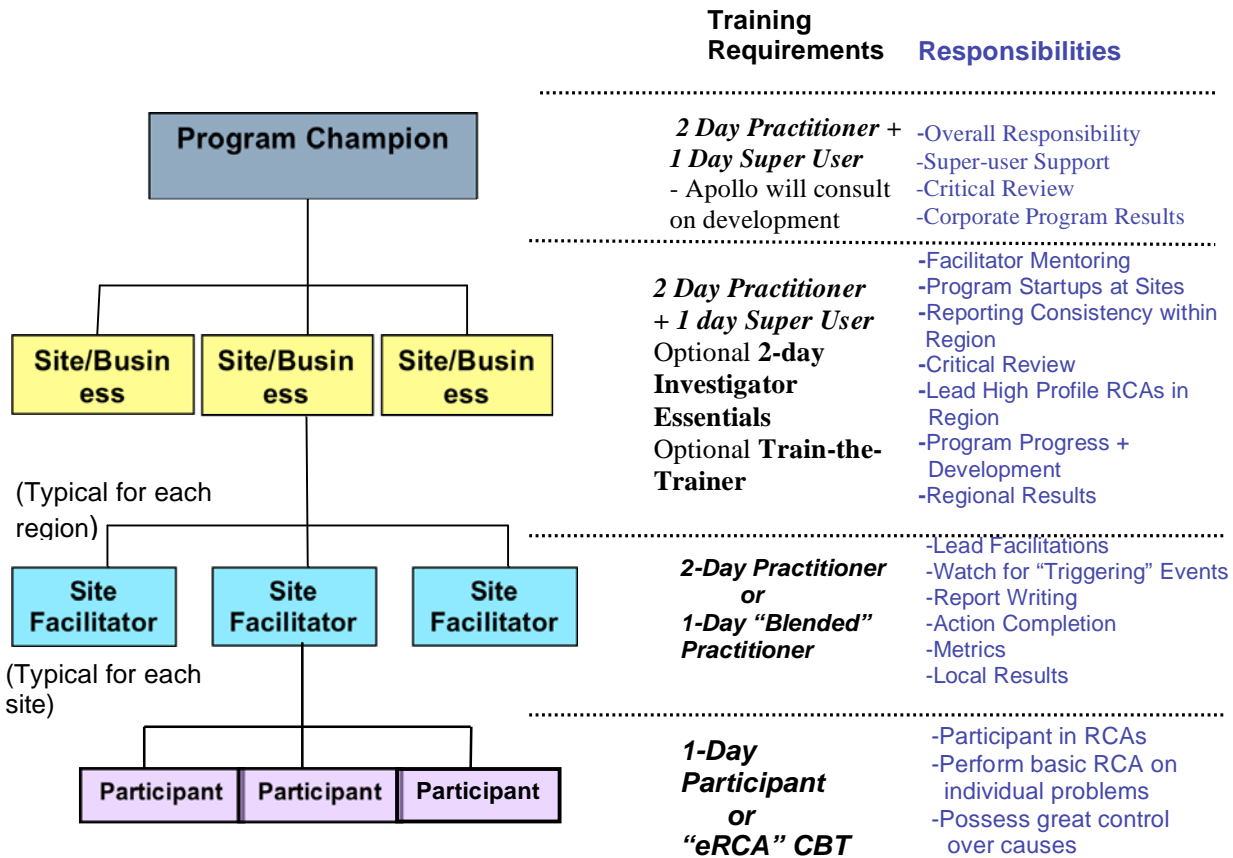
Other important steps in the early phase include determination of the depth of implementation and the development of a training strategy. Key questions must be answered:

- Is the hourly workforce going to be engaged in the problem solving process?
 - If so, are they to facilitate RCA's, or participate?
- Are we going to train all of the customer service representatives, or only the supervisors?
- Do we expect operators to report out the results of their analyses, or will the engineers handle this?
- Should we have the managers go through the facilitator's training to develop an understanding of what is involved and to show support for the program?
- Are we going to train enough people to where an internal Apollo Certified Instructor makes sense?

The answers to these and other questions are essential to the development of your total program approach to problem solving. We recommend that once you finalize your RCA program goals, you develop and communicate a summary of these goals to your organization. The RCA goals should also be written into leaders personal goals to assure alignment and priority within the organization extends down to the front line.

Apollo will assist you with all aspects of the program setup. The setup phase focuses on establishing an organizational structure whereby the program can be delivered to all functions and geographies within the organization while maintaining consistency with the method across functional and geographical boundaries.

Organizational Roles + Responsibilities



Program Champion

The Program Champion has the primary responsibility for the entire Apollo RCA program. The role includes providing the interface with the Leadership team concerning the logistics of implementation and long-term oversight. The champion guides the development of the training strategy and deployment of the training, metric deployment, information sharing, networking, and mentoring.

The Champion role requires a firm time commitment during the initial implementation, however long term, the time commitment decreases considerably and entails occasional support, metric tracking and mentoring of new Super Users.

The Program Champion will be linked up with an Apollo representative who will serve as the long-term point contact to assure the necessary programmatic features found in this document are understood.

Attendance of the Practitioners and Super User courses is recommended for all Program Champions. On-going consultation with an Apollo representative will occur as needed.

Super-Users

The development of Super-users will be dependent on the Program Goals and scope of the implementation. For Programs where Apollo RCA is to be used as an enterprise wide problem-solving tool, development of Super-users on a site-wide or business-wide level will be appropriate.

The Super-users serve as the subject matter experts (SME) for the RCA program and may lead the “high profile” investigations. Super-users are capable of providing the mentoring needed in the early stages of facilitator development. The Super-user role may or may not be a full time position. Initially, during the program rollout, Super-users would likely require a “special assignment” where they could focus on skill building and deployment. Super-users should be determined by function and/or geography to achieve success across the organization.

The Super-users are trained on and fully aware of the client's metrics and organization goals as they apply to the Apollo RCA program. Super Users supply the functional capacity to leverage information and learnings across the organization globally.

Attendance of the Practitioners and Super User courses is required. If the Super-user will be leading “high profile” events, the 2-day Artemis “Investigator Essentials” course is recommended.

Facilitators (Practitioners)

Facilitators are trained to act as the primary analysis leaders and lead the bulk of the RCA's in most organizations. They should be selected on the basis of organization function and geographic location. The Facilitators lead the RCA team through the Apollo RCA process to arrive at the final solutions. The Facilitator is responsible for completing the RCA report.

Attendance at the 2-day “Apollo RCA for Practitioners” course or 1-day “Blended Apollo RCA for Practitioner” course is required.

The number of facilitators is dependent on the goals of the program. Apollo will provide guidance on determining an appropriate number of facilitators.

Participants

The participants are an important element as they represent the population of employees that work directly with the clients tools, equipment and procedures, and they typically are in a prime position to recognize causes that exist at the ground floor level. Participants are active members of the RCA team, however they will not be expected to serve as facilitators.

Participants could be any client employee, contractor or supplier. The recommended training would be either the 2-day “Practitioners”, 1-day “Participants”, or “eRCA: Foundations of Problem Solving” computer-based training course.

Managers & Supervisors

While each element of this program is essential to institutionalizing effective problem analysis, leadership's role is perhaps the most important, especially in the early stages of implementation.

Apollo has found that all successful RCA programs share active and visible leadership support. This support typically comes in two forms: 1) Communication of the Program Goals prior to the rollout, and 2) Ongoing support of the program at the different levels. Without a clear understanding of the goals and objectives of the RCA program at all levels, success will be limited. The first step to achieving clarity of RCA program objectives is to have the RCA Program goals written into the personal goals of senior leadership and cascade down throughout the organization. This will assure the necessary alignment and focus.

Apollo recognizes that most Managers will never conduct an analysis, but they need to assure high quality RCA's are performed in their organization. To assure success, the manager must be knowledgeable about the key elements of an effective problem analysis and should be capable of providing "critical review of RCA's. The 4-hour "Apollo RCA Manager Overview" provides the necessary insights on these two aspects and is recommended for all managers with RCA programs in their areas.

Suppliers

Many problems facing organizations today are created by the inadequate work processes and work products originating at the suppliers. Suppliers introduce defects into an organization's systems, which costs significant time and money to correct. Typically, most suppliers underestimate the negative impact their problems create for their customers because either the problem is solved after it arrives at the customer and they never learn of it, or the customer simply accepts it as inevitable. Apollo has found that engaging suppliers in the problem solving process is very often overlooked and is a huge, untapped opportunity. At a minimum, suppliers should be conducting RCA's within their organization and submitting the results to their customers to explain any deviations.

Today, few companies possess the resources needed to investigate all the problems within the organization. If you make RCA investigations a condition of doing business with you, the supplier will certainly oblige when they deliver a non-conforming product or service, and it will not tax your resources. If you enact this policy, expect to get some "push-back" by the supplier when you direct them to get trained in Apollo. This is normal. What may surprise you later is when the supplier calls you back to thank you for requesting the training. After training, most suppliers immediately see the value and applicability of the Apollo Method and realize that it is a great tool for solving problems.

When suppliers are part of a customer's RCA investigation, it is almost certain that they will walk away with: 1) A greater appreciation for their client's needs, 2) Better solutions to help eliminate the problems, and 3) More energy devoted to ensuring the solutions are institutionalized from their end. Normally, the supplier will leave the RCA with a very positive impression and will thank their customer for skipping the "blame and punishment" approach and for inviting them to be an equal player in the problem solving process. Another interesting discovery is that not all of the causes lie at the supplier; many causes of the supplier's problems are the result of, and are caused by, gaps in your organization's systems and work processes. When both parties sit down as equals in the problem

solving process, the resulting analysis reflects the collective wisdom of everyone and inevitably results in better solutions.

If you are interested in engaging your suppliers in Apollo RCA, you can either invite the supplier to sit in on your training, or you can ask that they contact Apollo directly to arrange for their own training. There are many options to accomplish this task. Should you desire, Apollo can even coordinate the supplier training via open seminars conveniently located near your suppliers.

Deployment Time Frame

There is no one single recommended deployment time frame that is suitable for every company. Deployment time frame is going to be dependent on the Program goals. For example, it would be reasonable to propose that if an organization would like a “holistic” program where by they plan to train everyone from the senior leaders down to the front line workforce, for example 5,000 included employees, a 2 year implementation period will likely be appropriate. If the plan is to train all 100 people within a manufacturing site, one could reasonably expect the program deployment to be completed in a single month.

For incidents that will involve Participants who are unfamiliar with Apollo RCA, the “eRCA” computer-based training program provides a “just in time” education on the Apollo Method thus enabling them to arrive at the RCA session fully aware of how Apollo RCA works and what they need to do to contribute. The module takes approximately 2-1/2 hours to complete and can be obtained directly from the Apollo website at www.apollorca.com with a credit card payment.

Metrics

The key metric that needs to be developed for any effective RCA program is the one that measures the Program Value. Although one could argue that problem recurrence is an important metric, ultimately, we are concerned with the consequences of that problem. By focusing on Program Value, we are keeping our eye on how well we are eliminating or mitigating these consequences. Since the consequences of most incidents can be expressed in terms of their financial impact, we can easily make the business case for the value of RCA. We can also enable individuals to understand how they connect and contribute to the business when they track the “value” for each RCA they facilitate.

The RCA Program Value, in its simplest form, is the summation of the benefits of the individual RCA’s. The individual RCA results are measured after the solutions have been implemented and allowed to “soak” in. The savings that results from an RCA is the difference between the consequences of the problem prior to the RCA and the consequences seen after all RCA solutions are implemented over an annualized time frame. Typically, one should allow a solution to work for about 6 months after it is implemented before its effectiveness is measured.

Value of RCA Program (Example)

Lets look at an example where an organization wants to understand the value of their RCA program by looking at 2 different RCA's: 1) A safety problem where 5 people/year suffer hand lacerations at a bag emptying station, and 2) A repetitive failure of a centrifuge that results in \$100,000/failure of lost profit and \$20,000/failure of out of pocket costs.

First, we must quantify the total losses to the organization by summing the **Significance** sections from the **Problem Definitions** for both events **PRIOR** to the implementation of solutions:

Problem Summation Prior to RCA's

| <i>Significance</i> | <i>Case 1) Hand Lacerations</i> | <i>Case 2) Centrifuge Failures</i> | <i>TOTALS</i> |
|--|---------------------------------|------------------------------------|--|
| <i>Safety</i> | OSHA reportable hand laceration | N/A | 5 OSHA reportable hand lacerations/year |
| <i>Environmental</i> | N/A | 150 lbs Acetic Acid spill/failure | 450 lbs Acetic Acid spill/year |
| <i>Revenue/Customer Service/Production</i> | \$5,000/injury | \$100,000 lost profit/failure | \$325,000/year |
| <i>Out of Pocket Costs/Maintenance</i> | \$3,000 | \$20,000/failure | \$75,000/year |
| <i>Frequency</i> | 5/year | 3/year | |
| <i>Total Problem Cost</i> | \$40,000/year | \$360,000/year | \$400,000/year |

Now, once the RCAs are complete and the solutions are implemented for the above two situations, we follow up on the observed results for a one year period.

These results yield:

Observed Results after RCA Solutions Implementation

| <i>Significance</i> | <i>Case 1) Hand Lacerations</i> | <i>Case 2) Centrifuge failure</i> | <i>TOTALS</i> |
|--|---------------------------------|-----------------------------------|---|
| <i>Safety</i> | OSHA reportable hand laceration | N/A | 1 OSHA reportable hand laceration/year |
| <i>Environmental</i> | N/A | 150 lbs Acetic Acid spill/failure | 150 lbs Acetic Acid spill/year |
| <i>Revenue/Customer Service/Production</i> | \$5,000/injury | \$100,000 lost profit/failure | \$105,000/year |
| <i>Out of Pocket Costs/Maintenance</i> | \$3,000 | \$20,000/failure | \$23,000/year |
| <i>Frequency</i> | 1/year | 1/year | |

| | | | |
|----------------------------------|--|--|--|
| <i>Cost of RCA and solutions</i> | \$2,000 | \$13,000 | \$15,000 |
| <i>Total Problem cost</i> | \$8,000/year +\$2,000 (1 time only) | \$120,000/year + \$13,000 (1 time only) | \$128,000/year + \$15,000 (1 time only) |

By comparing the “before” and “after” picture, we see:

Savings Resulting from RCA Program

| <i>Significance</i> | <i>Before RCA</i> | <i>After RCA</i> | <i>SAVINGS</i> |
|--|---|--|--|
| <i>Safety</i> | 5 OSHA reportable hand lacerations/year | 1 OSHA reportable hand laceration/year | 4 OSHA reportable hand lacerations/year |
| <i>Environmental</i> | 450 lbs Acetic Acid spill/year | 150 lbs Acetic Acid spill/year | 300 lbs Acetic Acid spill/year |
| <i>Revenue/Customer Service/Production Out of Pocket Costs/Maintenance</i> | \$325,000/year | \$105,000/year | \$220,000/year |
| <i>Frequency</i> | | | |
| <i>Cost of RCA and solutions</i> | | \$15,000 | -\$15,000 |
| <i>Total Problem cost</i> | \$400,000/year | \$128,000/year + \$15,000 | \$272,000/year - \$15,000 |

So, if we utilize some very fundamental economics, ignoring the time value of money, we see:

Program Value Summary (Example)

Program value = Savings as a result of RCA’s – Costs of RCA
 = **4 fewer OSHA reportable injuries/year**
 + **300 fewer lbs/year Acetic Acid spills**
 + **\$272,000/year additional profit**
 - **\$15,000 (cost of RCA & solutions)**

Should you be able to assign a value to the injuries and spill costs, the entire benefit of the RCA program can be quantified and the return will be even more attractive.

Looking at the cost benefits over a 3 year period:

Program value/3years = **12 fewer OSHA injuries**
 + **900 fewer lbs of Acetic Acid spilled**
 + **\$811,000 added profit** (((\$272,000 x 3)– \$15,000/3))

Payback Period = Time needed for analysis and solution costs to payoff

Payback Period = Cost of RCA/(Savings/unit time)

For the 3-year look, disregarding the benefits of fewer injuries and spills, our payback is:

Payback = \$15,000/\$272,000/year
= 0.055 years
= ~ 3 weeks

For an actual look at the value and payback seen in an independent audit of over 100 RCAs in the chemical industry, refer to [Appendix 1](#).

Threshold Criteria

A very important RCA program element is the Threshold or “trigger” criteria. Threshold Criteria are predetermined values that, once exceeded, dictate when the Apollo RCA process should be applied and an RCA performed. These values correspond directly to each section of Significance in Problem Definition. As the size and magnitude of events decrease over time, the threshold values should be lowered until the payback reaches the company’s minimum target payback ratio.

Example Threshold Criteria

Safety: OSHA Recordable

Environmental: Air or water permit non-compliance, or uncontrolled release of ammonia, or 100 lb spill of gasoline to the soil, etc.

Customer Service: Customer complaint, or 5% late deliveries, or 1% of billing errors, etc.

Revenue: \$20,000 lost profit incident, or 10 hours of production downtime, or 2 hours of network outage, etc.

Out of Pocket Costs: \$10,000 unplanned expenditure due to contractor costs, overtime, maintenance labor and materials, waste disposal, Municipal fines, etc.

Frequency: Repeat events > 4 times per year.

Refer to example Trigger List in [Appendix 2](#). word to pdf

Apollo is available to assist with development of “Trigger” or “Threshold” criteria specifically tailored to your goals and objectives if you desire

Reporting

Effective reporting is a necessity within the RCA program. Besides communication of the findings and corrective actions, the reporting process establishes credibility for the analysis by effectively creating a visual dialog through the cause and effect chart where all causes are presented in an easily understood manner. Credibility is important because eventually the RCA team will be seeking financial and human resources to implement the proposed solutions.

In addition, effective reporting allows others in the organization with similar problems to learn from the results of the RCAs. The result may be the application of effective solutions in other areas of the organization without the need to perform multiple analyses on similar events.

The bare minimum recommendation for effective reporting includes a summary report and the cause and effect diagram. The summary report consists of: 1) Problem Definition, 2) Cause and Effect Summary Statement and 3) Solutions. The cause and effect chart should always be included with the summary report. A simple example Apollo Report is shown in [Appendix 3](#).

For facilitators who desire a quick and effective tool to build their RCA reports, we recommend use of *RealityCharting®* software. *RealityCharting* not only reduces the time needed to develop the report, it also keeps the user within the rules of the Apollo Method through use of built-in rules checks and wizards. See [Appendix 4](#) for more information on *RealityCharting*. To preview a free demonstration of *RealityCharting*, please visit the Apollo website at www.apollorca.com.

Corrective Action Tracking System

Any effective program should include both a means of assuring solution implementation and auditing to verify that the solutions were effective. Should the client already have a corrective action tracking system in place, Apollo will provide a review of the system to insure that its format follows the functionality of the RCA process. Apollo will also assist in the development of a tracking system should the client require one as a part of agreed project scope.

Quality Control

Apollo understands that at the root of our success is our client's success. Until the client develops its own internal resource for critical review of analysis, Apollo will provide this service. Apollo will review, on a non-disclosure and confidential basis, a specified number of "threshold level" events for the purpose of providing feedback and constructive coaching to the facilitators as they hone their skills.

After the organization's Super Users are developed, they will normally take over the role of "critical reviewer" and provide the ongoing feedback to the facilitators.

Continuous Improvement

Once your RCA program has been deployed, sharing of RCA reports through your internal networks helps to not only leverage the results, but leads to organizational learning and systems thinking. Apollo recommends that the RCA facilitators meet on a regularly scheduled basis (either face-to-face or on-line collaboration) for the purpose of sharing RCAs. At a minimum, a distribution list should be created so that facilitators can quickly pass along their reports. The networking should occur at both a site level, and at a business unit level. For example, if a facilitator resides in Business Unit X of Site 1, they should share their RCA reports to all Business Unit X facilities around the world, and they should share with all Business Units located at Site 1.

RCA PROGRAM "GAP ASSESSMENT"

After your RCA program has been in place for 1-1/2 to 2 years, it will be beneficial to perform a "gap assessment" against best practices to determine additional improvement areas for your RCA program. The output of the gap assessment is a list of recommendations that will increase the value of your

program and shore up areas of weakness. The assessment is based on qualitative and quantitative evaluations, comprised of questionnaires, audits and interviews that are conducted at multiple levels within the organization. Key areas examined include: use of threshold criteria, understanding of roles and responsibilities, metrics tracking and results measurements.

Apollo can provide additional information on a Gap Assessment for your organization.

APPENDIX 1- EFFORT vs. PAYBACK FOR RCA

Data gathered on use of the Apollo method in the chemical industry, has shown the following averages¹:

Cost and Time per RCA

Average Time/RCA

| | |
|--|----------------|
| Team meeting to develop C/E chart (5 people @ 1 hr) | = 5 hr/RCA |
| Report writing, communication, action implementation | = 10 hr/RCA |
| Misc (Lab failure analysis, testing, etc) | = 5 hr/RCA |
| <hr/> | |
| Total Person hours/RCA | 20 hours/RCA |
| Total Cost/RCA (@\$75/hr) | \$1,500 |

Payback after implementation

Average value² (\$ profit) returned/RCA = \$17,000/year

Payback/RCA = \$17,000/\$1,500 = 11 fold after 1 year

Payback Period = \$1,500/\$17,000/yr = 1 month

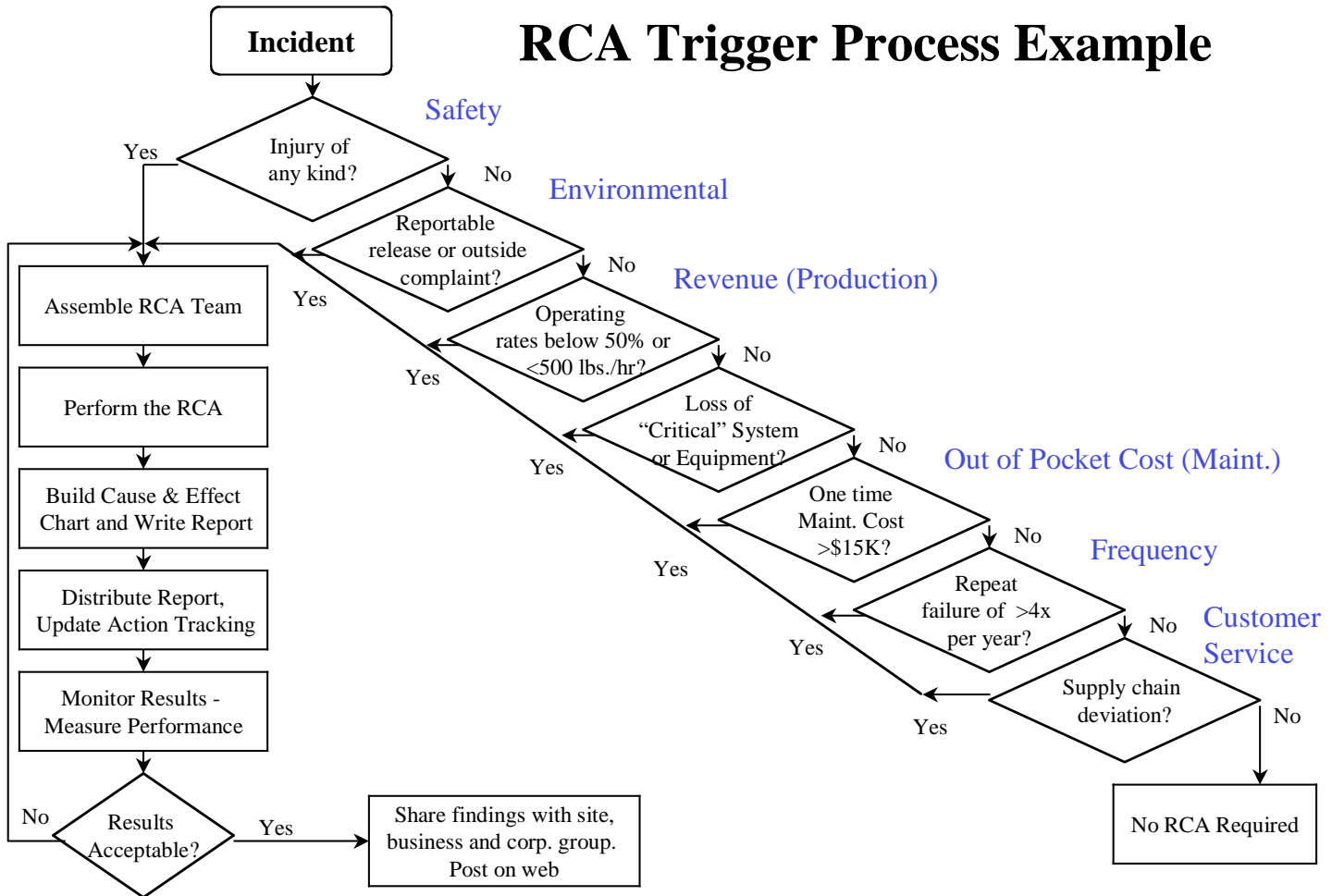
Notes:

- 1) Study includes over 100 client RCA's between 1996 and 2006.
- 2) Value is defined as the combined profit from decreased maintenance costs and increased profit from improved Asset Utilization (AU) for sold out plants. This number is the average of sold-out, non-sold out, batch and continuous plants in the chemical industry. For plants that weren't sold out, the "Average Value" number included only the maintenance and operational savings numbers where no additional profit from improved AU was realized. In sold out plants, it was not uncommon to see \$50M - \$75M/year value returned/RCA; in some cases, this number can be substantial--one systemic problem that was solved in a plant resulted in an annual added value (pure profit) of approximately \$1,000,000/year. The problem had existed for seven years and had never been solved until the RCA was completed.

The above "value returned" figures include capital costs (annualized over the life of the improvement--normally 10 years) required to implement the solution.

APPENDIX 2- EXAMPLE THRESHOLD CRITERIA

RCA Trigger Process Example



APPENDIX 3- EXAMPLE RCA REPORT

(The following RCA Summary Report and C/E Chart were generated by RealityCharting)

Purpose: To prevent recurrence, not place blame.

Report Date: 9/1/2006
Date Investigation Started: 8/21/2006
Report Number: RCA-2006-12

I. PROBLEM DEFINITION

WHAT: Shutdown of plastics production line

WHEN: 24-Jul-2006 (last failure)
Relative When: During normal operation

WHERE: Plastics Business
Location: Houston, TX
System: Pellet Conveying
Component: Blowers B-100 and B-200

SIGNIFICANCE:

Safety: N/A
Environmental: 20 lbs/day polystyrene vented to atmosphere
Revenue: \$60,000 lost profit/year
Cost: \$30,000 repair costs/year
Combined Cost: \$90,000/year
Frequency: 6 times in last year.

II. CAUSE & EFFECT SUMMARY

The six shutdowns of the plastics production line thus far this year have been caused by the loss of vacuum to operate the pellet transfer system. The loss of vacuum is caused by the main blower tripping out on high amps and the back-up blowers not starting. The main blowers are tripping because they are filling with water, and the spares won't start because they seize due to rust. The main blowers are filling with water due to the water vapor present in the conveying air, there is no knockout pot and it is a closed loop conveying system. The spare blowers are rusting because they are steel, they are exposed to air and they also are filling with water. The discharge piping of the blowers tie together and there are no isolation valves. The water vapor is present because the pellets are being pulled into the airvey line after the water bath, which operates at 150F, and the air dryer is not working. The dryer doesn't work because the condenser plugs frequently with solids because polymer and/or pellets accumulate. The dryer is never cleaned because there was never a PM put in place to clean it. The pellets accumulate because the bag filters break occasionally because they are not the appropriate material to use for this service. The polymer accumulates because the residual monomer present polymerizes. The monomer is present because the un-reacted monomer in the pellets is not stripped out because there is no stripping system. The lack of a stripper, lack of a knockout pot and lack of a PM to clean the condenser were caused by engineering not anticipating the need for these things.

III. SOLUTIONS

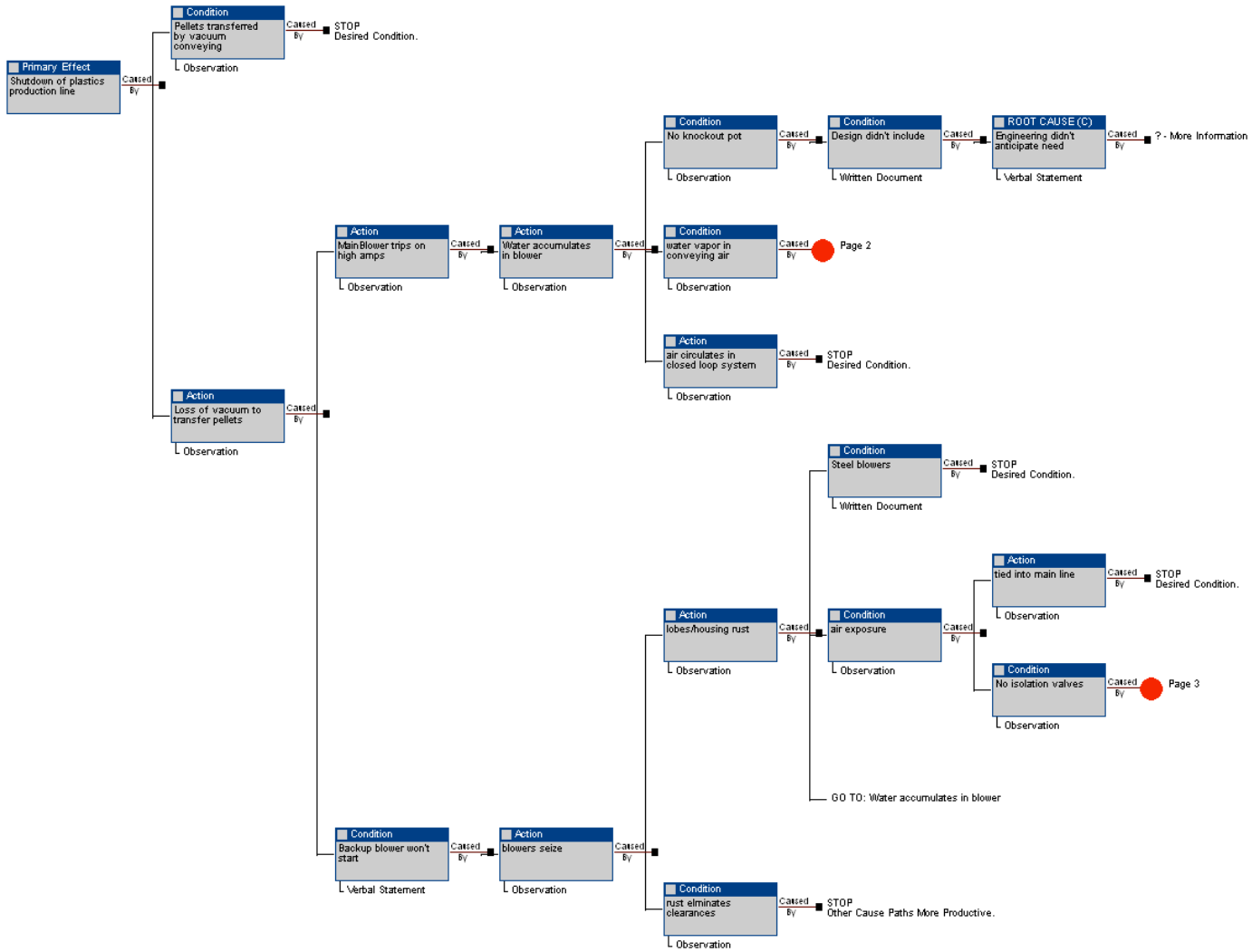
| CAUSES | CORRECTIVE ACTIONS | NAME | DUE DATE |
|------------------------------------|--|--------|-----------|
| Engineering didn't anticipate need | Update engineering standards and specs | Wilson | 9/15/2006 |

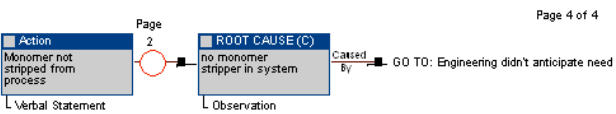
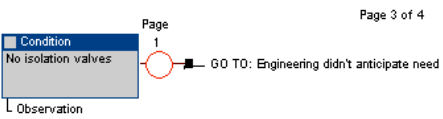
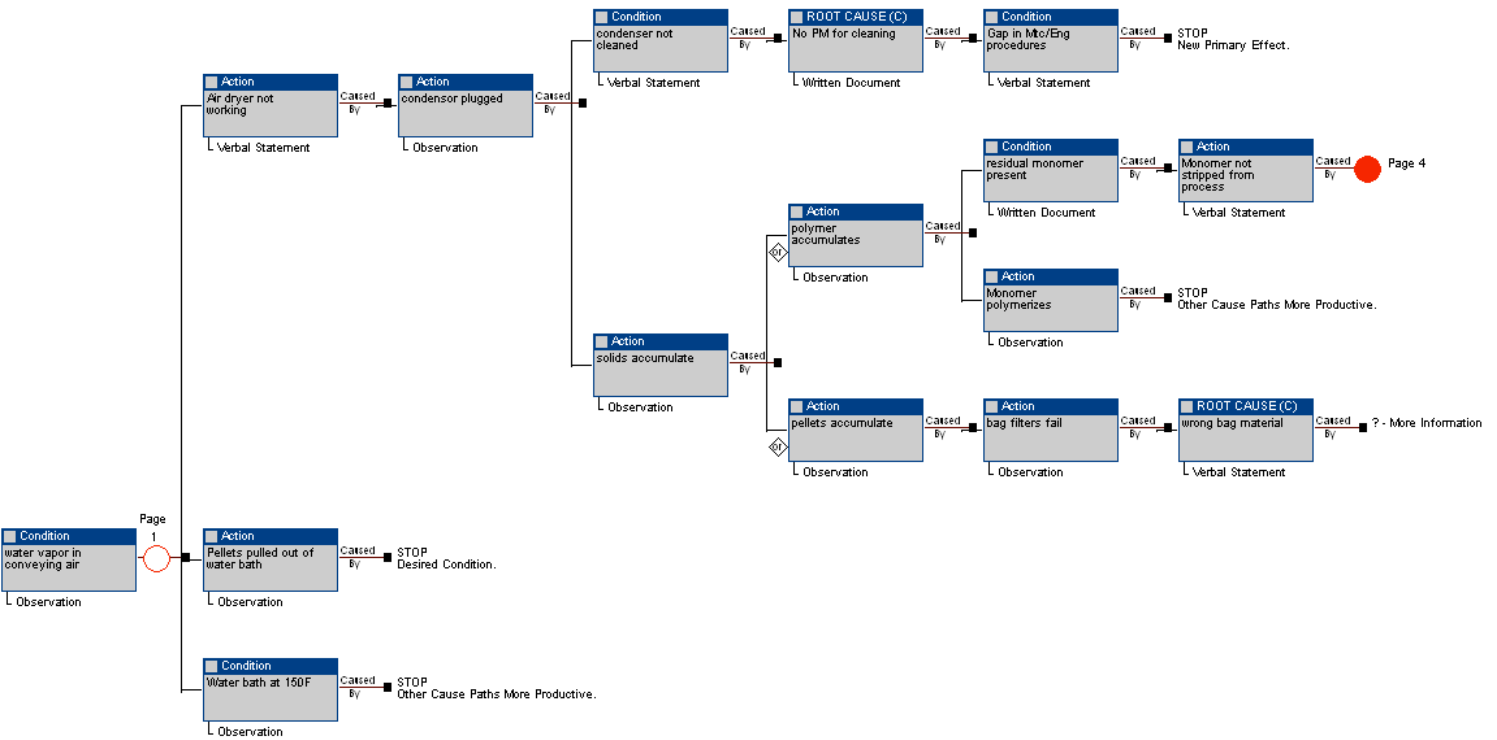
| | | | |
|-------------------------------|--|--------|------------|
| | to reflect the RCA learnings | | |
| Wrong bag material | Change bag material to Gore-tex | Jones | 10/11/2006 |
| No monomer stripper in system | Install vacuum jets to strip and recover monomer | Didier | 11/10/2006 |
| No PM for cleaning | Add quarterly condenser cleaning to CMMS PM system | Jones | 9/15/2006 |

IV. INVESTIGATION TEAM MEMBERS:

Didier, Jones, Smith, Wilson, Zane

Contact Joe Jones at 123-456-7890 for more information.





APPENDIX 4 - REALITYCHARTING™ SOFTWARE

At the request of many of our clients, we developed the RealityCharting™ software program specifically to help conduct root cause analysis investigations with the Apollo methodology. RealityCharting™ offers a step-change in the way an Apollo root cause analysis investigation is created and documented. In all, RealityCharting™ is a tool that adds great value by expediting timely analysis composition, consistent with the rules of the Apollo method. All students trained in the Practitioners course receive a copy of RealityCharting as part of their training.

- **Robust Problem Solving Software**
- **Accurate and Timely Analysis**
- **Create Apollo Cause & Effect Charts**
- **Simple, Intuitive, Powerful Communications Tool**

SYSTEM REQUIREMENTS:

Microsoft Windows 98 or higher

64 Mb RAM

10 Mb of hard-disk space for application

CD –ROM drive

300 MHz processor or higher

100 Mb of hard-disk space for virtual memory

16 bit color video display adapter or Truecolor display

TO ORDER CALL: Apollo Associated Services, LLC: Telephone (281) 218-6400 x-109
1560 West Bay Area Blvd, Suite 140, Friendswood, TX 77546

