

Control Chart Dashboards

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FLUOR[®]

Introduction

- **The Dashboard as a management tool**
- **Color coding and trending**
- **Integrating with SPC and Theory of Variation**
- **Creating dashboards using Excel spreadsheet**
- **The “FluorBoard”: publication and acceptance**

What is a Dashboard?

Dashboards and “Balanced Scorecards” have been proposed as a communication tool and Executive Summary

Can take a variety of inputs, and display them in one place

“Analog aesthetics meets digital information”

(<http://www.ambientdevices.com/cat/dashboard/>)

Dashboard History

- **The balanced scorecard is a new management concept which helps managers at all levels monitor results in their key areas. An article by Robert Kaplan and David Norton entitled "The Balanced Scorecard - Measures that Drive Performance" in the *Harvard Business Review* in 1992 sparked interest in the method, and led to their business bestseller, *The Balanced Scorecard: Translating Strategy into Action*, published in 1996.**

(<http://www.isixsigma.com/offsite.asp?A=Fr&Url=http://www.skymark.com/resources/methods/balancedscorecard.htm>)

Dashboard Concept

- **Operational Dashboard: focuses on managing and measuring business and process activities in real time or near-real time. Operational dashboards provide deep visibility on a specific business area or business process activity. Key Performance Indicators and metrics are typically displayed by an assortment of dials, gauges and stoplights that resemble those found in a commercial plane cockpit.**

http://www.dmreview.com/editorial/dmreview/print_action.cfm?articleId=1000940

Energy Facility Contractors Group (EFCOG)

- Savannah River implemented the Key Performance Indicator format for corporate metrics in 2001.
- Using the experience of WSRC, the EFCOG ISM Performance Metric Sub Group worked to develop a process and format for the DOE Complex.
- In December 2001, Undersecretary Bob Card asked EFCOG and Bev Cook, EH-1, to develop a system for use by the DOE Complex. He asked that this system use a common format, similar to the one used by *WSRC EFCOG Performance Metrics Manual* published by WSRC

<http://www.efcog.org/Best%20Practices/Approved/Best%20Practices9.html>

EFCOG (WSRC) Format

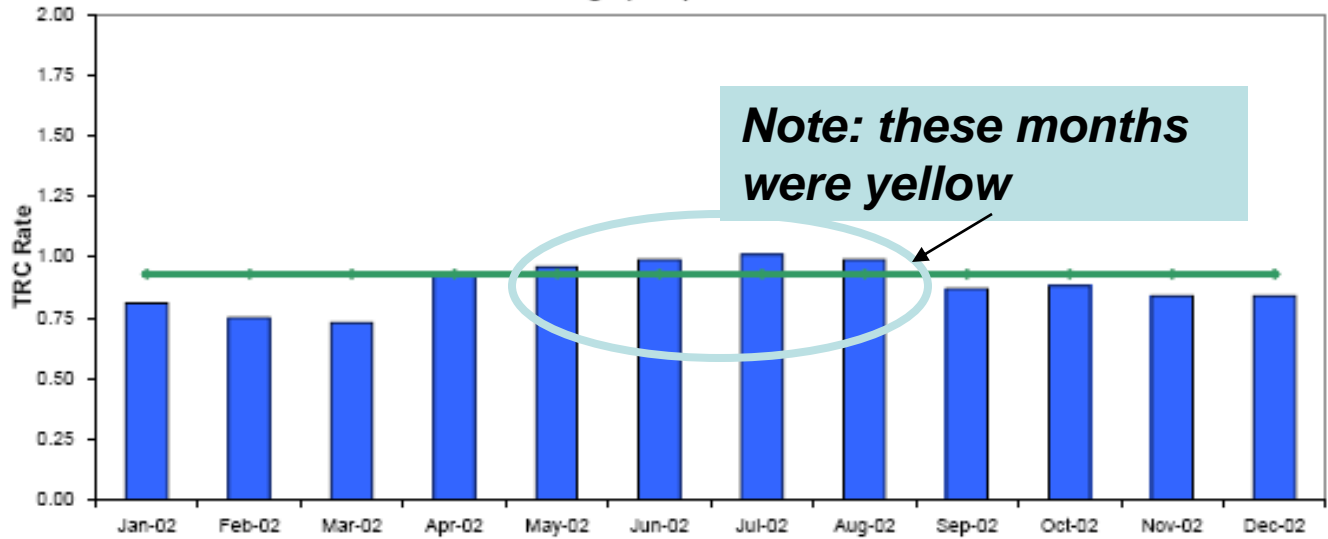
- Cover sheet with colored panes, with 4 additional squares for the last 4 quarters performance

| Focus Areas | Site Level Annunciator Panel and Examples of Level 1 Inputs | | | | | |
|--|---|------------------------------|--------------------------|-------------------------|---------------------------|--------------------------|
| Management Systems | Regulatory Performance | Quality Assurance | Safety Culture | Authorization Bases | Stakeholder Relations | |
| Operational Performance | Radiation Protection | Industrial Safety and Health | Criticality Safety | Safeguards and Security | Project Management | Fire Protection |
| | Work Planning and Control | Emergency Preparedness | Environmental Protection | Near Misses | Transportation Management | Waste Management |
| Infrastructure and Facility Management | Systems and Equipment Essential to Safety | Construction Management | D&D | ER | Maintenance | Configuration Management |

<http://www.efcog.org/Best%20Practices/Performance%20Metrics.htm>



Focus Area
Level 1 Title
Total Recordable Case Rate Performance Metric
Through (date)



Note: these months were yellow

| Data | Jan-02 | Feb-02 | Mar-02 | Apr-02 | May-02 | Jun-02 | Jul-02 | Aug-02 | Sep-02 | Oct-02 | Nov-02 | Dec-02 |
|-------------------|--|--------|--------|--------|--------|--------|---|--------|--------|--------|--------|--------|
| TRC Rate | 0.81 | 0.75 | 0.73 | 0.94 | 0.96 | 0.99 | 1.01 | 0.99 | 0.87 | 0.88 | 0.84 | 0.84 |
| Goal | 0.93 | 0.93 | 0.93 | 0.93 | 0.93 | 0.93 | 0.93 | 0.93 | 0.93 | 0.93 | 0.93 | 0.93 |
| Score | | | | | | | | | | | | |
| Definition | The Occupational Safety and Health Act of 1970 requires covered employers to prepare and maintain records of occupational injuries and illnesses. The company measures safety performance in accordance with these guidelines. The incident rates are calculated by multiplying the number of injuries, illnesses or lost workdays by 200,000 and dividing that by the total number of work hours. | | | | | | Analysis / Action TRC is GREEN. Analysis: When compared to the previous month, the TRC rate has increased slightly. Four TRC cases occurred during the month -- one was a carpal tunnel syndrome injury, requiring surgery. Action: Office ergonomics will continue to be an area of focus across the site. | | | | | |
| Goal | TRC Goal = 0.93 Blue = 0.0-0.80 Green = 0.81-0.93 Yellow=0.94-1.00 Red ≥ 1.00 | | | | | | Comments Scoring levels were reviewed 2 months ago with a decision not to change it at this time. Another review is scheduled for 3 months from now. DOE KPI Owner: John Smith (xxx-xxxx); Contractor KPI Owner: Joe Doe (xxx-xxxx); Contractor SME: Jane Brown (xxx-xxxx) | | | | | |

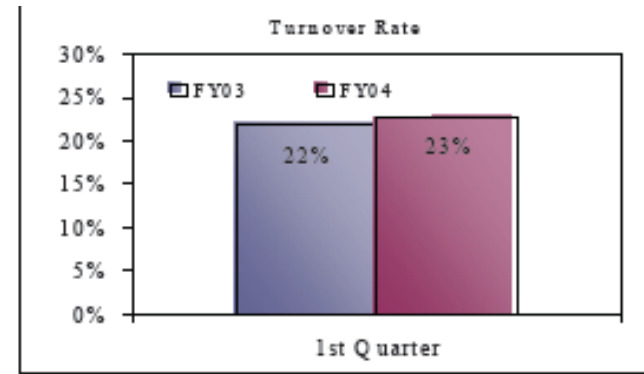
EFCOG Format Shortcomings

- **Only 12 data points shown**
- **Evaluated against numerical targets**
- **No use of statistical trending**
- **The extra four squares confused people**
- **Reaction to random noise**
- **Manipulation of criteria occurs in order to make things Green**
- **Manipulation (and destruction) of systems occurs in order to make the targets**

Another Example



Turnover Rate has increased slightly since the same time period last year, but remains below industry norms. The Turnover Rate for the first quarter (Q1) in FY04 was 1% more than the first quarter of last fiscal year, but the total number of employees increased by 4% (1,289 employees on July 1, 2002, 1,340 employees on July 1, 2003). Seventy-eight employees were terminated between July 1 and September 30, 2003, compared to seventy employees during Q1 of FY03.



This was from the “Vinfen Corporation” and the Balanced Scorecard Institute materials.

What does this mean, and why is it yellow?

Creating a Management System (Review)

- **Dr. Ackoff, Creating the Corporate Future**
- **Three Management Functions:**
 - Identifying actual and potential problems (threats and opportunities)
 - Decision making (what to do and doing it, or having it done)
 - Maintaining and improving of performance under changing and unchanging conditions

Desirable Dashboard Features to Keep

- **Overview many facets of performance simultaneously**
- **Avoid masking trends in individual facets (as compared to an index)**
- **“Drill down” to lower organization levels**
- **Use color coding (“stoplight”)**
- **Provide a “quick read”**
- **Provide bias for action, for execution**

New Features Needed

- **Be predictive and proactive (act on emerging trends rather than react to levels)**
- **Minimize reaction to random noise and false alarms**
- **Recognize when stable systems are not performing well**
- **Incorporate risk models / graded approach**
- **Determine effects of previous decisions**
- **Achieve good “Feedback and Improvement” (ISMS) characteristics**

Statistical Process Control (Review)

- **Segregation into Common Cause and Special Cause variation**
- **Minimization of Type I and II errors**
- **Use of specific rules to declare a “trend”**
- **Has proven to be effective, time saving, and inexpensive at Hanford**

The “FluorBoard”

- A method to incorporate SPC and Colors was first proposed at Hanford in 1997
- “Stoplight Charts with SPC Inside” published by American Society for Quality 2004
- Has been in place as the Fluor Hanford Dashboard since FY 2005
- Utilized existing and familiar performance indicators

Metrics Charting Safety Performance

Combining statistical tools provides quality data

By Steven S. Prevette

STATISTICS AND INJURY RATE CALCULATIONS can be the source of many problems. It is not unusual for the numbers that cause difficulties, but how those numbers are used. The first item on the agenda of a typical safety meeting is a laundry list of last month's injuries and everything being done to prevent their recurrence. The next month, the same things happen again and a completely new list of preventive strategies is generated. Each month managers and SH&E professionals react to the latest results, and incorporate new and ever-different fixes. In these situations, the numbers are driving the actions, rather than the actions driving the numbers. Wheeler refers to this behavior as “numerical illiteracy” (Wheeler).

This article describes how to make the numbers work for the company, instead of the company working for the numbers. To do this, one must look at the ways numbers have been commonly viewed, and contrast that view with an alternate, statistically credible way to look at numbers. Statistical process control (SPC) and control charts have long been used in industry for trending operational, quality and safety data. Color-coded dashboards have recently come into use for displaying information to management. This article discusses a method that combines the best of SPC techniques with the display methods found in “balanced scorecards” and dashboards.

Steven S. Prevette is a statistician with Fluor Hanford in Richland, WA. He supports performance indicators across a broad spectrum of areas, including safety, environment, operations, maintenance and quality. His customers include three Department of Energy (DOE) sites—Hanford, Fernald and Los Alamos—and several DOE contractors. Prevette holds a B.S. in Civil Engineering from Virginia Tech and an M.S. in Operations Research from the Naval Postgraduate School in Monterey, CA.

This methodology has been used at Fluor Hanford, a contractor at the U.S. Department of Energy's (DOE) Hanford site in Washington. The massive project on the former nuclear materials production site is considered one of the largest environmental cleanup projects in the world. Fluor Hanford has achieved significant safety improvements—including more than an 80% reduction in OSHA cases per 200,000 hours worked over the last 9 years. These improvements were achieved by a committed partnering of workers, managers and statistical methodology.

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Safety achievements at the site have been due to a systematic approach to safety. This includes excellent cooperation between field workers, SH&E professionals and management through application of OSHA's Voluntary Protection Programs principles. The corporation's values are centered around safety. Fluor Hanford has taken a rigorous approach to using its safety statistics, based on Shewhart's control charts, and Deming's management and quality methods (Shewhart; Deming).

An Example of Numerical Illiteracy

Typically, a company looks at numbers such as injury rates by comparing this month to last month, or by comparing this month to a numerical goal. This is a simple, yet damaging approach. Assume that the past 25 months of data looked like those in Figure 1. Calendar year 2005 began well, with 8 injuries in January and only 3 injuries in February. Notice the fine decreasing trend from July 2004 through February 2005. The organization cashes in its safety recognition money and throws a party.

Following the success in February, something went wrong in March. The numbers jumped from 3 injuries in February to 13 for March—an increase of more than 400%. April and May recover somewhat, but not by much.

Moving Averages

Next, let's try a 12-month moving average. This is a tool used by many companies, and it is regularly included in M.B.A. quantitative methods courses (Anderson, et al). The moving average in Figure 2 has smoothed out the data. Safety performance is improving after all. A similar result occurs if one adds a “trend line” using a least-squares fit (or, more properly, linear regression). These statistical methods show that there is an improving trend.

Color Coding

At this point, management is confused. Conflicting analyses have been presented. Something seems to be amiss and management believes the current performance is not acceptable. Warning improve-

Converting SPC Results to Colors

| Control Chart Result | Decision | Color | Leadership Action |
|---|--------------------------------|---------------|------------------------------------|
| Stable (common cause variation) | Level is Acceptable | Green | Stay the Course |
| | Level is Not Acceptable | Yellow | Improve System |
| Trend (special cause variation) | Adverse | Red | Corrective Action |
| | Improving | Green | Reinforce – Stay the Course |

Refinements

- **Use WHITE if Stable at an “okay” level, but opportunity for improvement exists**
- **Use WHITE if currently Yellow or Red, but one month away from an improving trend**
- **Use YELLOW if one month from a non-improving trend**
- **Use RED if stable beyond a regulatory or customer specified threshold**

Selection of Measures

- **Ideally, the dashboard should reflect the management systems and business objectives**
- **Many times we chose the measures and then try to figure out what the objective was**
- **Be careful of wanting what you can measure versus measuring what you want (Ackoff)**
- **Leading indicators should be considered also**

Example Measure and Definition

- **OSHA Recordable Case Rate**
- **Definition:** Multiply the number of OSHA recordable injuries and illnesses by 200,000 and divide by the total number of work hours.
- **Data Source:** Injuries from EX3 Reporting System. Hours from HANDI with supplemental Subcontractor data.
- **Red:** Statistically significant non-improving trend, or a stable above 2.9 cases per 200,000 hours (Contingency Payment of Fee is two quarters at 2.9)
- **Yellow:** One point away from a statistically significant non-improving trend, or a stable between 1.0 and 2.9. **Basis:** The FY 2005 DOE baseline goal is 1.0.
- **White:** Stable between 0.75 and 1.0. **Basis:** The FY 2005 DOE stretch goal is 0.75, and the Fluor CY 2005 corporate goal is 0.75. If currently Yellow or Red, and one point away from a statistically significant improving trend, then set to White.
- **Green:** Statistically significant improving trend, or stable less than 0.75. **Basis:** this is less than both the DOE stretch goal and the Fluor corporate goal.

Trend Criteria

- **Individual points** outside the **Control Limits**.
- **Seven points** in a row all above average or all below average.
- **Seven points** in a row increasing or decreasing.
- **Ten out of eleven points** in a row all above average or all below average.
- **Cycles or other non-random patterns** in the data.
- **Two out of three points** in a row outside of two standard deviations above/below the **average**.
- **Four out of five points** in a row outside of one standard deviation above/below the **average**.

Low Rate Special Case:

- **When data have been zero for more than 7 data points in a row, or more than 10 of 11 in a row, the baseline average will be shifted to zero.**
- **When baseline average is zero, a significant trend will be noted if there are more than 2 non zero values in 8 data points, or more than 3 non zero values in 12 data points. The chart will be marked as Yellow for one month. On the following month, a non-zero baseline will be established, and the chart evaluated against its existing color criteria for baseline averages.**

Creating a Dashboard Presentation

- **An effective dashboard may be created on a fileserver using readily-available Excel spreadsheet**
- **Excel offers the capability to perform Statistical Process Control**
- **Colors are set manually**
- **Hyperlinks are established in order to open indicator definitions, and chart pages**
- **Conditional Formatting is used to color the panes in the dashboard**

Pane Colors

| Indicator (with link to definition) | FH Overall | PFP | K Basins | FFTF |
|--|------------|----------|----------|----------|
| LEADING INJURY INDICATORS | W | Y | W | W |
| <u>First Aid Case Rate</u> | <u>Y</u> | <u>W</u> | <u>G</u> | <u>W</u> |
| <u>ORPS</u> | <u>W</u> | <u>W</u> | <u>G</u> | <u>W</u> |

Conditional Formatting (making the cell change colors automatically):

Click on cells to be colored

Select Format, then Conditional Formatting

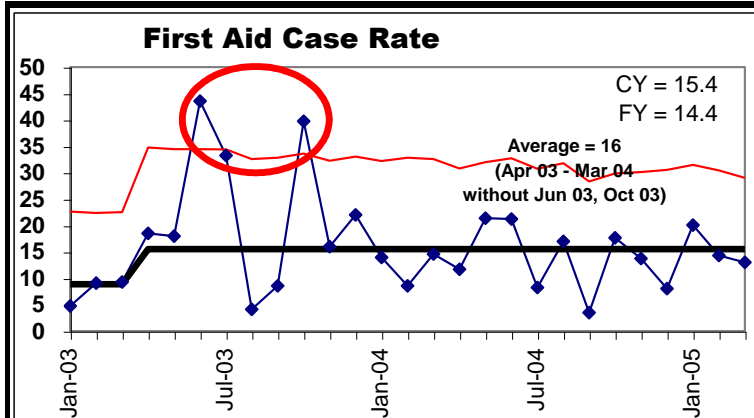
Enter Cell Value Is, Equal To, ="R", then hit Format Button

Set Patterns to Red, Font to White

Add>> two more, for Yellow and Green.

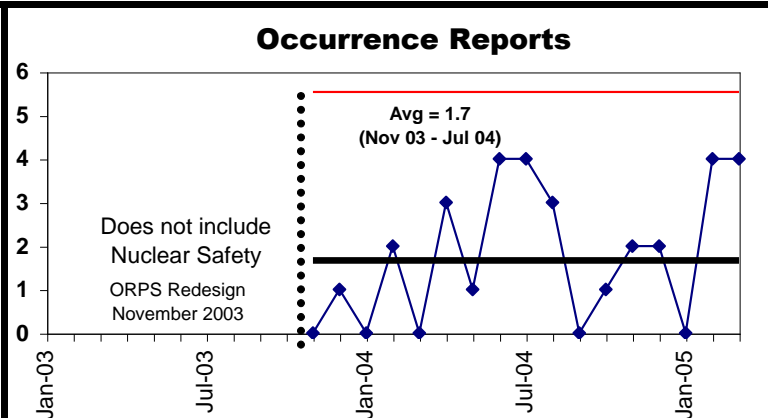
Charts

FPF - OS&H Leading Indicators - Page 1 of 2



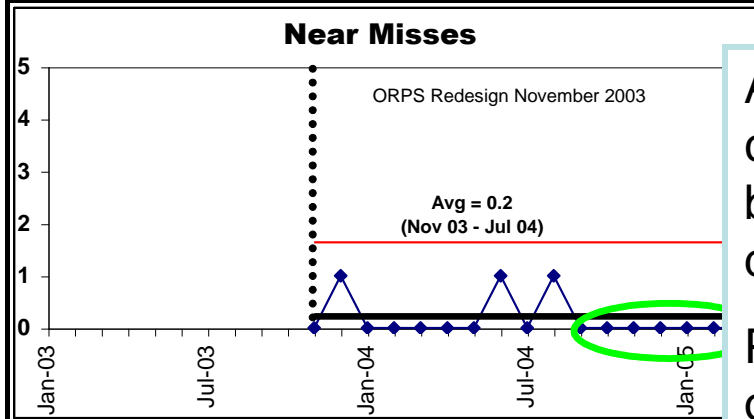
Case Rate Stable.

W



Stable at an acceptable level. Potential increasing trend however.

W



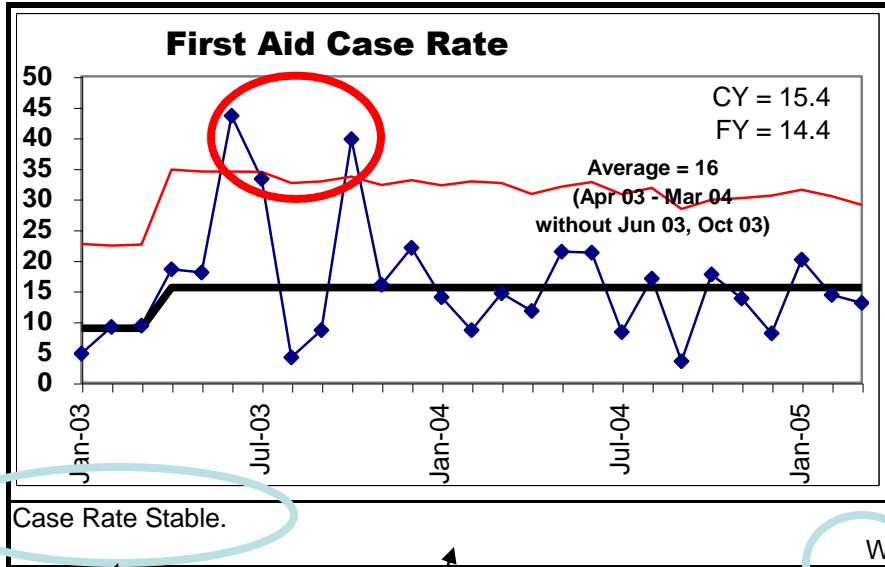
Seven months below average (at zero). Significant improving trend.

G

A 4 per page layout is a good compromise to keep it readable, but keeps the number of pages down.

Put chart definitions and ownership in a separate file.

Charts



Brief description of chart results.

Conditionally format these cells to change color

Color Code letter for the chart in its own cell.

Each chart has the past two fiscal years, plus the current year.

SPC baseline and control limits added.

Control limit towards the non-improving direction is made Red, improving direction is Green.

Trends are circled.

CY and FY rates may be added (and the box automated with a "concatenate" command on the source data file).

Links to Charts

| Indicator (with link to definition) | FH Overall | PFP | K Basins | FFTF |
|--|------------|----------|----------|----------|
| LEADING INJURY INDICATORS | W | Y | W | W |
| <u>First Aid Case Rate</u> | <u>Y</u> | <u>W</u> | <u>G</u> | <u>W</u> |
| <u>ORPS</u> | <u>W</u> | <u>W</u> | <u>G</u> | <u>W</u> |

Hyperlinks

Right click on the cell

Select “Hyperlink”

Browse through files until you get to the desired file

Select “OK”

Now, whenever someone left clicks on the cell, the linked file will open

Do the same for chart definitions.

Links to Colors

| Indicator (with link to definition) | FH Overall | PFP | K Basins | FFTF |
|--|------------|----------|----------|----------|
| LEADING INJURY INDICATORS | W | Y | W | W |
| <u>First Aid Case Rate</u> | <u>Y</u> | <u>W</u> | <u>G</u> | <u>W</u> |
| <u>ORPS</u> | <u>W</u> | <u>W</u> | <u>G</u> | <u>W</u> |

Cell References

Click on the cell desired to be colored

Enter “=”

Window to the file with the Chart in it

Click on the cell under the chart with the chart color code

Hit “Enter”

Finishing Touches

- **Setup these files on a fileserver**
- **Give out access**
- **Extra links may be added next to charts for lessons learned, managers' comments, or any additional information that may be useful.**

FluorBoard: September 2005

| Indicator (with link to definition) | FH Overall | PFP | K Basins | FFTF | WS&D | SW/GW/VZ + WSCF | CP D&D & RCC | CS&I |
|--|------------|----------|----------|----------|----------|--------------------|-----------------|----------|
| LEADING INJURY INDICATORS | W | W | W | G | W | G | G | Y |
| First Aid Case Rate | <u>W</u> | <u>W</u> | <u>Y</u> | <u>W</u> | <u>Y</u> | <u>G</u> | <u>W</u> | <u>Y</u> |
| ORPS | <u>W</u> | <u>W</u> | <u>G</u> | <u>W</u> | <u>W</u> | <u>W</u> | <u>W</u> | R |
| Near Misses | <u>Y</u> | <u>G</u> | <u>Y</u> | <u>G</u> | <u>W</u> | <u>W</u> | <u>G</u> | <u>W</u> |
| No. Safety Inspections | <u>G</u> | <u>W</u> | <u>G</u> | <u>G</u> | <u>G</u> | <u>G</u> | <u>G</u> | <u>G</u> |
| Safety Inspection Scores | <u>G</u> | <u>Y</u> | <u>G</u> | <u>G</u> | <u>G</u> | <u>G</u> | <u>G</u> | <u>G</u> |
| HGET Survey | <u>G</u> | <u>G</u> | <u>G</u> | <u>Y</u> | <u>W</u> | <u>G</u> | <u>G</u> | <u>W</u> |
| Safety Related Employee Concerns | <u>W</u> | R | <u>Y</u> | <u>G</u> | <u>G</u> | <u>G</u> | <u>G</u> | <u>Y</u> |
| LAGGING INJURY INDICATORS | W | Y | G | G | G | G | G | Y |
| OSHA Case Rate | <u>W</u> | <u>Y</u> | <u>G</u> | <u>G</u> | <u>G</u> | <u>Y</u> | <u>Y</u> | <u>Y</u> |
| DAFW Case Rate | <u>Y</u> | <u>G</u> | <u>G</u> | <u>G</u> | <u>W</u> | <u>G</u> | <u>G</u> | <u>Y</u> |
| DART Case Rate | <u>Y</u> | <u>Y</u> | <u>G</u> | <u>G</u> | <u>W</u> | <u>G</u> | <u>G</u> | <u>Y</u> |
| Severity Rate | <u>G</u> | <u>W</u> | <u>G</u> | <u>G</u> | <u>G</u> | <u>G</u> | <u>G</u> | <u>G</u> |

Fluor Hanford Dashboard: January 2006

| Indicator (with link to definition) | FH Overall | PFP | K Basins | FFTF | WS&D | SW/GWVZ + WSCF | CP D&D | CS&I |
|--|------------|----------|----------|----------|----------|-------------------|----------|----------|
| LEADING INJURY INDICATORS | G | G | G | G | W | G | G | G |
| <u>First Aid Case Rate</u> | <u>G</u> | <u>G</u> | <u>Y</u> | <u>W</u> | <u>Y</u> | <u>G</u> | <u>G</u> | <u>Y</u> |
| <u>ORPS</u> | <u>W</u> | <u>W</u> | <u>G</u> | <u>Y</u> | <u>W</u> | <u>W</u> | <u>W</u> | <u>G</u> |
| <u>Near Misses</u> | <u>W</u> | <u>G</u> | <u>G</u> | <u>G</u> | <u>W</u> | <u>Y</u> | <u>G</u> | <u>W</u> |
| <u>No. Safety Inspections</u> | <u>G</u> | <u>G</u> | <u>G</u> | <u>G</u> | <u>G</u> | <u>G</u> | <u>G</u> | <u>G</u> |
| <u>Safety Inspection Scores</u> | <u>G</u> | <u>G</u> | <u>Y</u> | <u>G</u> | <u>G</u> | <u>G</u> | <u>G</u> | <u>G</u> |
| <u>HGET Survey Safety Related</u> | <u>G</u> | <u>G</u> | <u>G</u> | <u>G</u> | <u>G</u> | <u>G</u> | <u>G</u> | <u>G</u> |
| <u>Employee Concerns</u> | <u>W</u> | <u>G</u> | <u>G</u> | <u>G</u> | <u>Y</u> | <u>G</u> | <u>G</u> | <u>W</u> |
| LAGGING INJURY INDICATORS | W | W | G | G | Y | G | G | W |
| <u>OSHA Case Rate</u> | <u>W</u> | <u>G</u> | <u>W</u> | <u>G</u> | <u>G</u> | <u>G</u> | <u>G</u> | <u>G</u> |
| <u>DAFW Case Rate</u> | <u>W</u> | <u>G</u> | <u>G</u> | <u>G</u> | <u>Y</u> | <u>G</u> | <u>G</u> | <u>Y</u> |
| <u>DART Case Rate</u> | <u>G</u> | <u>Y</u> | <u>G</u> | <u>G</u> | <u>Y</u> | <u>G</u> | <u>G</u> | <u>W</u> |
| <u>Severity Rate</u> | <u>W</u> | <u>W</u> | <u>G</u> | <u>G</u> | <u>Y</u> | <u>G</u> | <u>G</u> | <u>G</u> |

Benefits

- **No special software need be purchased**
- **Uses relatively easy features in Excel**
- **Once one file is set up, it can be easily replicated and modified**
- **Presentation is kept simple, intuitive navigation for users**
- **Combines advantages of SPC with popularity of colors**

Pro-active Trending

- **The color is not just set based upon level, but also includes trends.**
 - **If you are currently at a good level, but there is a trend in the wrong direction, you will pick up a Yellow or Red**
 - **If you are currently at a bad level, but are making progress, you get positive reinforcement.**
- **Reinforces Defense Nuclear Facilities Safety Board (DNFSB) statements that trends are more important than level.**

Publication and Publicity

- **The FluorBoard was published by the American Society of Safety Engineers in May 2006 *Professional Safety***
- **The article generated a high level of interest with DOE Headquarters**
- **The September 2006 ISMS Best Practices Workshop included positive comments on this system by Assistant Secretary of Energy James Rispoli**

Conclusion

- **This methodology is a conjunction of:**
 - Statistical Trending
 - Color Coded Executive Summaries
 - Leading and Lagging Indicators
- **The methodology has been very effective in driving improvement, and delighting customers**