the American Society of Safety Engineers
vol 4, num 3
Fall 2007
THE JOURNAL OF SH&E RESEARCH

An Examination of Observations and Incidence Rates for a Behavior Based Safety Program

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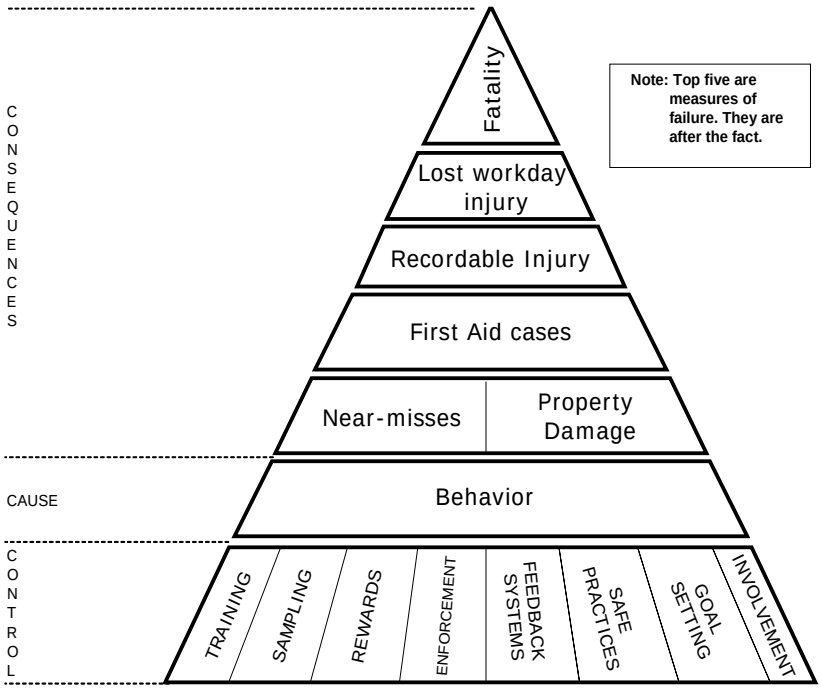
Abstract

This study examines the Behavior Based Safety (BBS) program of an oil production platform located off the coast of West Africa. The program has been in place at this 200-employee location since January 2002. All observation reports for 2003 were made available to explore relationships between behaviors recorded and incidence rates. A sample of 382 observation reports was selected from the 64,643 made during this period. Information extracted included the number and type of "safe" and "at-risk" behaviors observed, and the total number of observation reports completed. Relationships between the number of observation reports, types of behavior recorded, and four types of incidents – Injuries, Fires, Spills, and Near-Misses – were examined using an ordinal logistic regression model. Results showed that none of the regression coefficients were statistically significant (p-value>0.05); therefore, the number of observations made per day was not related to the number of incidents. With the number of daily observations ranging from 89 to 349, and each requiring approximately 15 minutes, the human-resource commitment is significant and management should give consideration to the current allocation of resources. It was noted that a limited time frame was examined and that results represent only one site of those using BBS programs.

1. Introduction

Behavioral Based Safety (BBS) is an approach designed to improve safety in the workplace by concentrating efforts in the behavior section of the safety pyramid (Fig. 1) as defined by Earnest (Earnest 1985). It involves observing behavior and detecting "at-risk" or unsafe activities, followed by directing or modifying behavior to achieve safe operation (Geller 1996, 1997, 2001). BBS is a popular approach to safety used in companies around the world. BBS programs have often been presented and explained by safety professionals, quality experts and psychologists, but have not been systematically evaluated to examine relationships between incidence occurrence and the implementation of the program. Evaluating the impact of BBS programs on incidence rate alone is often complicated by confounding factors and/or preexisting trends. For example, BBS studies often present cases of injury rate reduction that started before a BBS implementation making it difficult to determine a cause-effect relationship (Barton, et al. 1997) (Krause and Russell 1994). The goal of this project was to perform a detailed examination of a BBS implementation at one location of an international energy company. The study was developed with behavioral observations and data from an oil platform site that is located offshore of the Cabinda province in Angola. Quantitative and qualitative analyses were performed in an effort to examine relationships between the BBS program metrics and the occurrence of incidents.

Figure 1. Earnest safety pyramid (Earnest, 1985)



1.1 Takula Oil Field

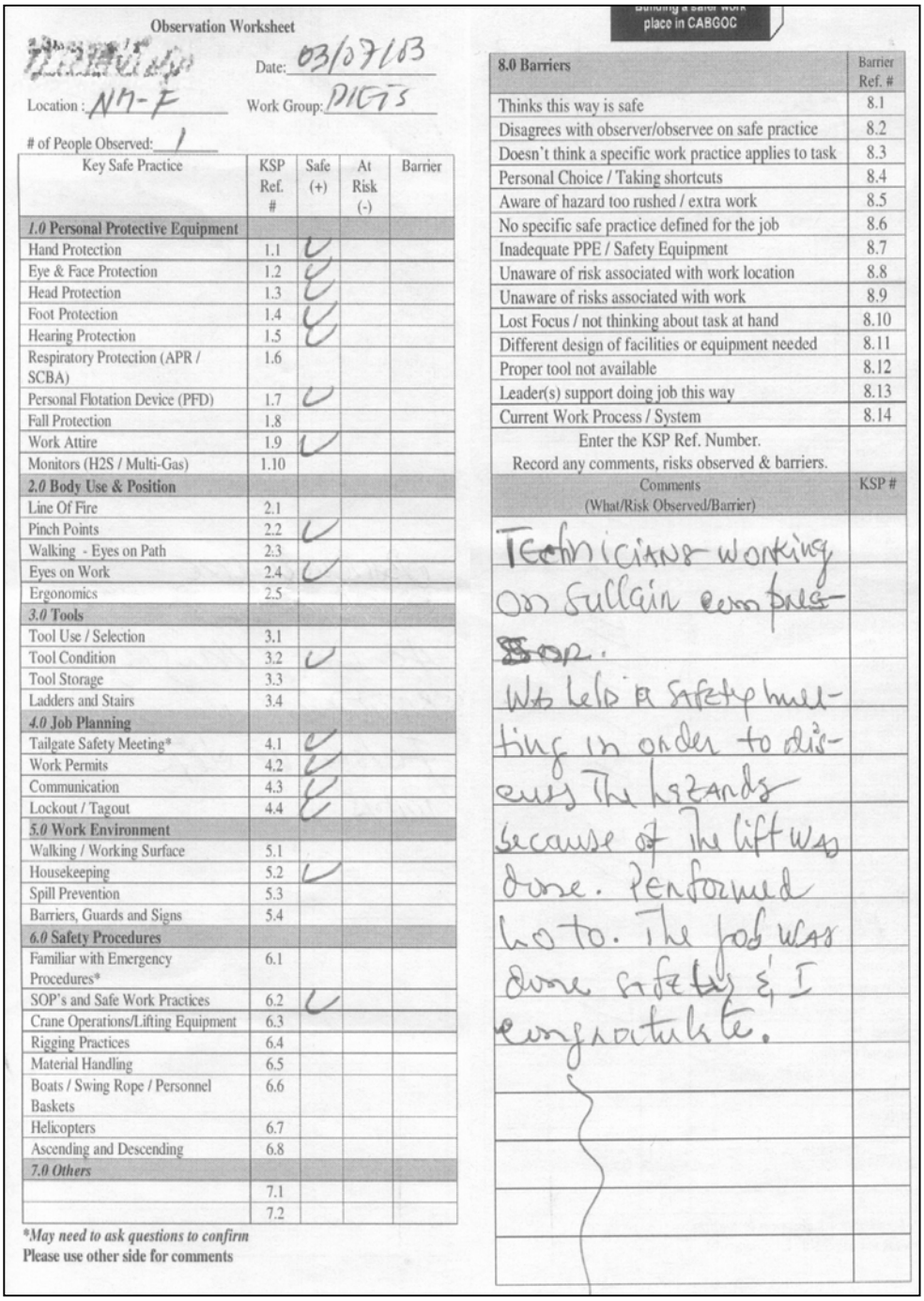
This case study was carried out at an oil extraction complex located in the Takula oil field. The complex consists of oil gathering stations (GS) and adjacent oil well jackets that extract and supply oil to the GS. Everyday safety-related activities include welding, confined space entry, electrical and chemical lock out and tag out, helicopter and boat transportation, and the use of hazardous chemicals. Activities are divided among three departments: Operations, Maintenance, and Production, including a small management team on site as well. Over 98% of the approximately 200 workers are Angola nationals.

1.2 BASIC Fundamentals

BASIC is the name for the behavioral safety program used in Takula. BASIC stands for Behavioral Approach to Safety Improvement in Cabinda. BASIC was developed from BBS fundamentals and started as a pilot initiative with only one ten-member team that started to perform behavioral observations on some of the platforms of the region in September 1999. By 2001, BASIC was perceived as a tool with potential to drive the injury rates down to zero at every site in the region, including Takula. The Takula platform started to keep track of the BASIC implementation process more rigorously in January, 2002, relying on BASIC as the primary tool for safety improvement. BASIC has become an integral part of everyday life: morning meetings begin with discussions about the previous day's observations, weekly charts and other information regarding BASIC are posted across the complex, and every employee carries their personal observation worksheet (OW) booklet. BASIC training is mandatory for all employees and is imparted on an annual basis. BASIC is one of the first training sessions every new employee receives. This training covers the fundamentals of BASIC concepts including why it is necessary to observe and how to perform observations.

BASIC, like most Behavior Based Safety programs, consists of training employees to perform a diagnostic of a particular operation or task from the safety perspective. This diagnosis or observation is developed using a worksheet with a list of predefined Key Safe Practices, or KSPs, which facilitate the task of detecting targeted behaviors for "Safe" or potential "At-Risk" conditions. It is based on the premise that "at-risk" behavior is the main cause of incidents. After making the observation, the observer will share with the team any comments or recommendations developed from this process. It is intended to stop any "at-risk" activity and maintain safety awareness among the organization. The Observation Worksheets (Fig. 2), in addition to general information such as location, name of the observer and date, include 36 Key Safe Practices (KSP) that were previously defined by the BASIC Team. In this particular case, they were defined by the corporate team onshore. The KSPs were defined as a general list applicable to the majority of the tasks and in direct relationship to the Standard Operating Procedures (SOP) of the region. The observation itself and the information in it constitute the bulk of the methodology. The goal is to provide management with credible and sufficient information to make appropriate decisions regarding safety issues.

Figure 2. Observation worksheet sample



Observation Worksheet

Date: 03/07/03

Location: NM-F

Work Group: DIGTS

# of People Observed: 1

Key Safe Practice	KSP Ref. #	Safe (+)	At Risk (-)	Barrier
***1.0* Personal Protective Equipment**				
Hand Protection	1.1	✓		
Eye & Face Protection	1.2	✓		
Head Protection	1.3	✓		
Foot Protection	1.4	✓		
Hearing Protection	1.5	✓		
Respiratory Protection (APR / SCBA)	1.6			
Personal Flotation Device (PFD)	1.7	✓		
Fall Protection	1.8			
Work Attire	1.9	✓		
Monitors (H2S / Multi-Gas)	1.10			
***2.0* Body Use & Position**				
Line Of Fire	2.1			
Pinch Points	2.2	✓		
Walking - Eyes on Path	2.3			
Eyes on Work	2.4	✓		
Ergonomics	2.5			
***3.0* Tools**				
Tool Use / Selection	3.1			
Tool Condition	3.2	✓		
Tool Storage	3.3			
Ladders and Stairs	3.4			
***4.0* Job Planning**				
Tailgate Safety Meeting*	4.1	✓		
Work Permits	4.2	✓		
Communication	4.3	✓		
Lockout / Tagout	4.4	✓		
***5.0* Work Environment**				
Walking / Working Surface	5.1			
Housekeeping	5.2	✓		
Spill Prevention	5.3			
Barriers, Guards and Signs	5.4			
***6.0* Safety Procedures**				
Familiar with Emergency Procedures*	6.1			
SOP's and Safe Work Practices	6.2	✓		
Crane Operations/Lifting Equipment	6.3			
Rigging Practices	6.4			
Material Handling	6.5			
Boats / Swing Rope / Personnel Baskets	6.6			
Helicopters	6.7			
Ascending and Descending	6.8			
7.0 Others				
	7.1			
	7.2			

May need to ask questions to confirm

Please use other side for comments

Building a safer work place in CABGOC

8.0 Barriers	Barrier Ref. #
Thinks this way is safe	8.1
Disagrees with observer/observee on safe practice	8.2
Doesn't think a specific work practice applies to task	8.3
Personal Choice / Taking shortcuts	8.4
Aware of hazard too rushed / extra work	8.5
No specific safe practice defined for the job	8.6
Inadequate PPE / Safety Equipment	8.7
Unaware of risk associated with work location	8.8
Unaware of risks associated with work	8.9
Lost Focus / not thinking about task at hand	8.10
Different design of facilities or equipment needed	8.11
Proper tool not available	8.12
Leader(s) support doing job this way	8.13
Current Work Process / System	8.14

Enter the KSP Ref. Number.
Record any comments, risks observed & barriers.

Comments (What/Risk Observed/Barrier)	KSP #
Technicians working on Sullain compressor.	
We held a safety meeting in order to discuss the hazards because of the lift was done. Performed LOTO. The job was done safety & I congratulate.	

BASIC observations are described as a random and voluntary process. Every worker on-site has the training and the right to observe their colleagues or teammates. Employees, contractors and even visitors are supplied with a booklet of ready-to-use observation

sheets. There is no quota defined or required for the number of observations to perform or turn in at the end of the day. Observations are never tallied per individual, but employees are always encouraged to perform as many as possible for the safety of everyone. Whenever an individual decides to make an observation, the observer will ask the Person-In-Charge for permission. Once the request is granted, the observation may begin. Instances where the request is not granted might represent a potential bias of the approach. This permission-to-observe principle is due to two factors: (1) the area has to be safe for people in the surroundings who are not involved in the task and are probably unaware of the risks involved, and second, (2) site employees have expressed that they feel more comfortable when they know the purpose of the individual observing the team. When the observation is completed, a feedback tailgate meeting is advisable if the conditions allow it. Observations are passed to the supervisor the next morning.

A team of volunteers and selected teammates called the "steering committee" is responsible for BASIC. The team holds a weekly meeting to discuss all the recent observations and related events. They then decide a course of action for the following weeks focusing on issues such as training needed, hot topic for the week, or rewards. Every week a new "hot topic" is selected. This is the result of the steering committee's discussion after reviewing the observations that were selected as "quality" observations for the week. Quality observations are usually those that include a very detailed comment on the operation, an observed "at risk" behavior or both. Information regarding the "hot topic" of the week is then e-mailed, posted in several boards of the facility and covered or discussed during the meetings of the week.

In order to maintain a record of the observations made, a special software program is used to upload information from the observations. This consists of a database file with a few very basic reports. An issue of concern with this software is that the current interface is somewhat difficult to use. As a result, only worksheets that are determined to be quality observations are selected and uploaded to the system creating a set of data that do not represent the original. Group achievements and performance are rewarded. Every week a "quality observation" is selected and a diploma is sent out to the site as recognition by the corporate office.

2. Methods

All observation reports for 2003 (a total of 64,653 observation worksheets) were made available by the BASIC team in Takula. The information extracted from observation worksheets consisted of the number of "safe" and "at-risk" behaviors observed and the type of observed behaviors. Types of behavior or Key Safe Practices (KSP) are detailed in Table 1. The observations included date, location, workgroup and number of people observed. Incident data from 2001 to the first quarter of 2005 as well as the number of weekly observations starting in 2002 were also available for this analysis. The overall goal of the project was to examine the null hypothesis that no relationship exists between the observation process and the occurrence of incidents, i.e., injuries, fires, spills, and near-misses:

H_o: No relationship exists between observations and incidents
H_a: A significant relationship exists between observations and incidents

Table 1. Key safe practices listed in the observation worksheet (OW)

KEY SAFE PRACTICES (KSP)
1.1 Hand Protection
1.2 Eye & Face Protection
1.3 Head Protection
1.4 Foot Protection
1.5 Hearing Protection
1.6 Respiratory Protection (APR/SCBA)
1.7 Personal Flotation Device (PFD)
1.8 Fall Protection
1.9 Work Attire
1.10 Monitors (H2S/Multigas)
2.1 Line of Fire
2.2 Pinch Points
2.3 Walking - Eyes on Path
2.4 Eyes on work
2.5 Ergonomics
3.1 Tool Use / Selection
3.2 Tool Condition
3.3 Tools Storage
3.4 Ladders and Stairs
4.1 Tailgate Safety Meeting
4.2 Work Permits
4.3 Communication
4.4 LockOut/TagOut
5.1 Walking / Working Surface
5.2 Housekeeping
5.3 Spill Prevention
5.4 Barriers, guards & signs
6.1 Familiar with Emergency Procedures
6.2 SOP's and Safe Work Practices
6.3 Crane Operations / Lifting Equipment
6.4 Rigging Practices
6.5 Material Handling
6.6 Boats /Swing Rope / Personnel Baskets
6.7 Helicopters
6.8 Ascending & Descending
7.0 Others

2.1 Sampling Strategy

The distribution of the number of observations per day during 2003 was analyzed further so that a sampling strategy could be developed for selecting OWs for the data set. Summary statistics are presented in Fig. 3. Results show that the daily number of observations follows a normal distribution with a mean of 177.1 observations per day and a standard deviation of 38.92 observations per day. With a normal distribution and a population of over fifty thousand observations, an appropriate sample size (ss) can be estimated using the following formula (Eckes 2000) (Juran, et al. 1974) (Systems 2003):

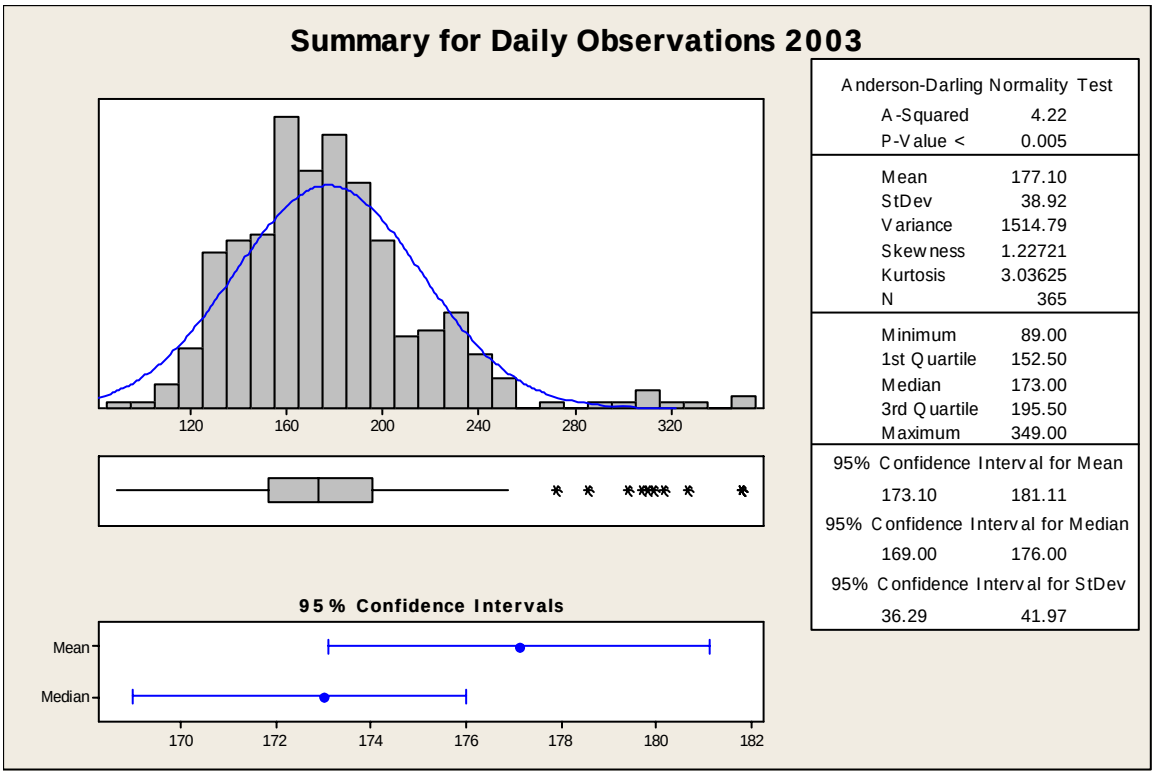
$$ss = \frac{Z^2 * (p) * (1 - p)}{c^2} \qquad \text{Equation 1}$$

where, Z is the Z-value (1.96 for a 95% confidence level), p represents the proportion defective expressed as a fraction (0.5 is used for a conservative sample size), and c is the confidence interval expressed as a fraction (e.g., ±5% = 0.05). Therefore, the sample size required is equal to 384 (ss = ((1.96)2 x (0.5)x(1 - 0.5)) / (.05)2 = 384.16 ~ 384). When the population is known, a correction can be made to obtain the exact number to be sampled :

$$\text{Adjusted } ss = \frac{ss}{1 + \frac{ss - 1}{pop}} \qquad \text{Equation 2}$$

resulting in an adjusted sampling size of 382 ((384)/ (1+ (384-1)/64,643)) = 381.7382 ~ 382) Therefore, it is expected that a sample of at least 382 randomly selected observation reports from the total set of 64,643 recorded in 2003 would adequately represents the original data set with a 95% confidence level.

Figure. 3. Statistical summary of daily observations for 2003 (Minitab®)



Given the fluctuations in the daily number of observations recorded, it was important to define a contribution to the sample data set in accordance with the number of observations developed for each day. The following criteria were used to maintain a distribution of daily samples in the sampled data set similar to that of the complete database (64,643 OWs) using the mean and standard deviation values from the summary statistics (Fig. 3). If the total number of observations for a given day in 2003 was $\leq(\bar{x}+2\sigma)$ (177 + 2 * 38.9 ~ 255), then one OW was randomly selected from this day to be included in the dataset. If the total was $>(\bar{x}+2\sigma)$ and $\leq(\bar{x}+3\sigma)$, then 2 observations were randomly selected from that day, and if the total was $>(\bar{x}+3\sigma)$, then 3 observations were sampled from that day. In other words, at least one observation was taken from each day. An additional observation was taken if the number of observations performed exceeded 255, and one more if the number exceeded 294. These criteria increased the number of observations for the sample/dataset to 383.

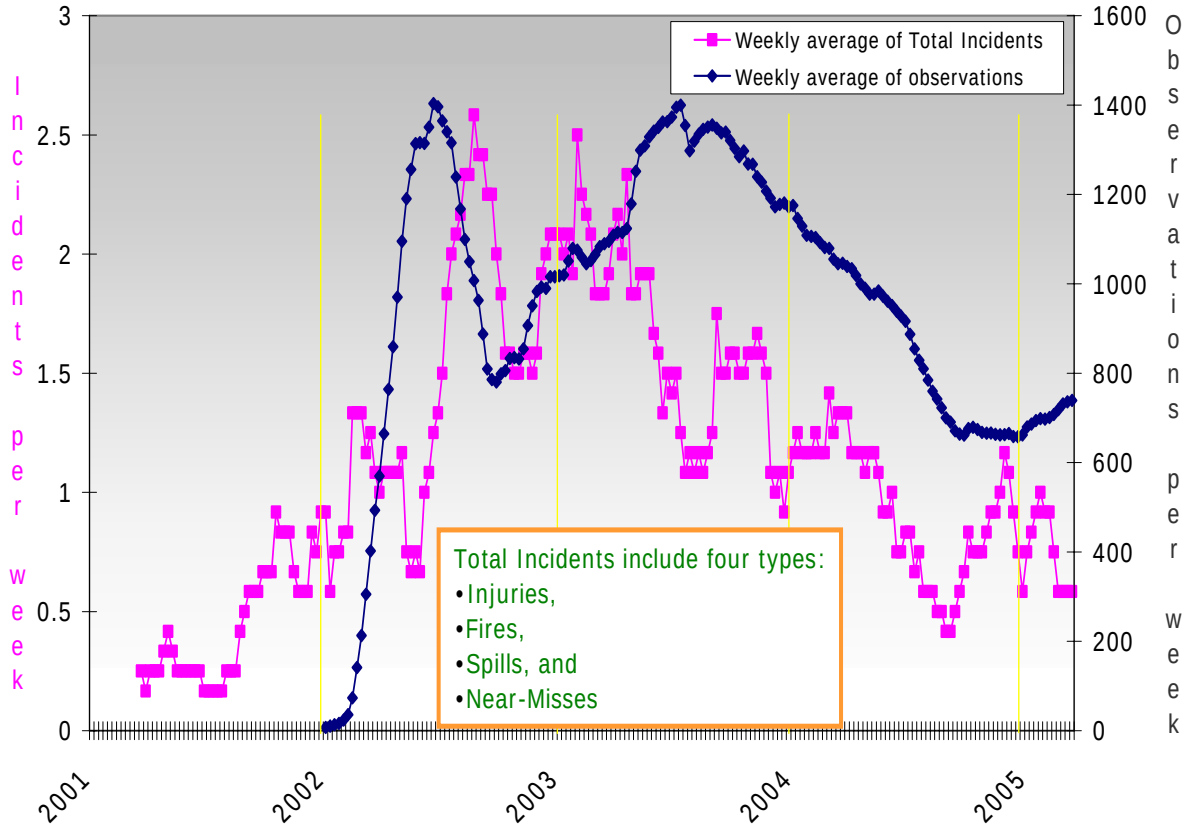
In order to avoid a biased selection process, a random sample was required. The observations dataset was sorted by date, following no particular order for location, department, workgroup or observer. For each required observation, a random number between 0.0 and 1.0 was generated and multiplied by the number of observations in that specific day. The resulting number was then rounded to the nearest integer. This number was used to start counting the observations - when the number in the table was reached,

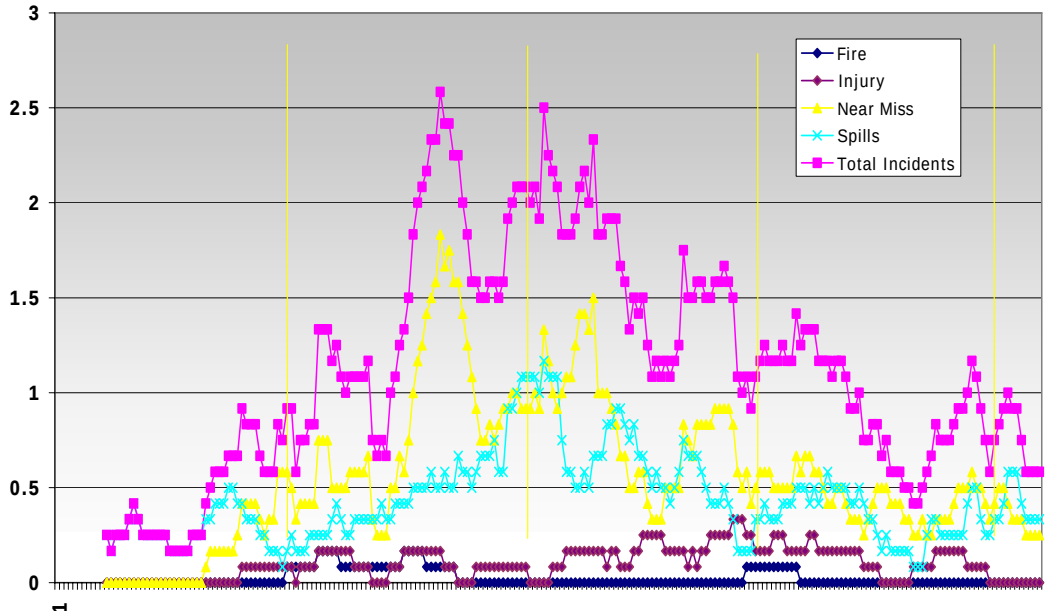
the observation in hand was then moved to the sample dataset group. The information from each sample was captured using a database file that emulates the observation worksheet in order to facilitate the information upload. The database entry form consisted of fields corresponding to the observation worksheets including location, workgroup, comments, and each of the KSPs.

3. Results and Discussion

The BASIC program was implemented in 1999, but the numbers of observations and results were not properly recorded or documented until 2002. A comparison over time of the number of observations and incidence occurrence is presented in Figure 4. A moving average of thirteen weeks (one quarter) was used to smooth the data for this chart. The resulting information is useful for a qualitative analysis but cannot be used for quantitative testing due to the time dependence created. Near misses and spills account for most of the incidents. On first examination, it appeared that the number of observations recorded was directly related to the number of incidents. Additional charts were prepared to more thoroughly examine the time profile of observations and incidents, and to characterize the distribution of observations among the different locations and work groups, and to summarize the behaviors observed.

Figure 4. Incidents and observations per week, 2001 – 2005 (13-week moving average).

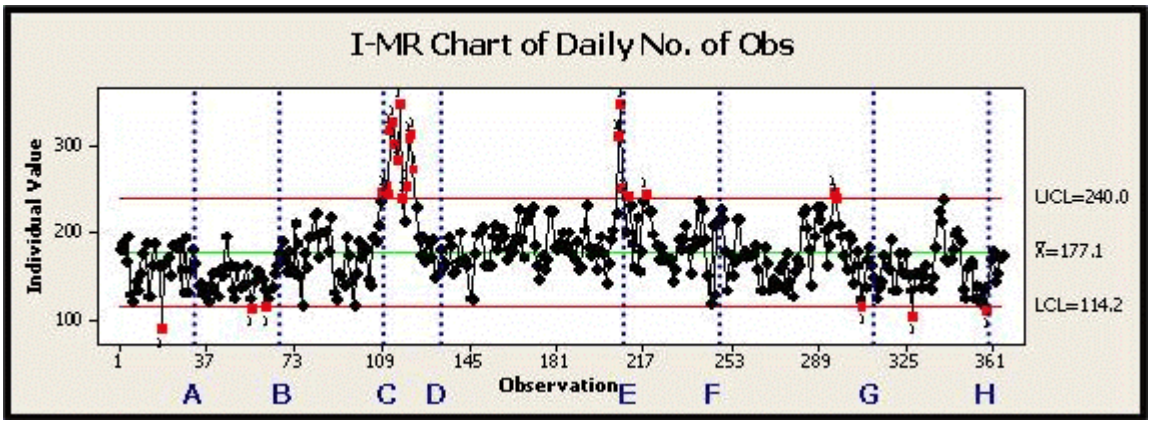




3.1 Qualitative Analysis

A control chart for the daily number of observations was prepared to detect any specific time-dependent pattern (Fig. 5). This chart could show whether days deemed to be "out of control" might represent the organization's reaction to an incident. This assumption was discarded when compared to the incidence occurrence shown in the control chart. A total of 78 incidents occurred throughout 2003 (1 fire, 9 injuries, 40 near misses, and 28 spills). Several incidents are included in Fig. 5 to allow a comparison of the potential effect in the number of observations developed after each incident. Although some events do precede high numbers of observations, most events do not appear to affect the number of observations made. Therefore, a relationship could not be established; however, this analysis only takes into consideration the number of observations and not the information contained in them.

Figure 5. Control chart for daily observations with significant incidents noted (A.- 7 near misses and 2 spills in one week, B.- Recordable injury, C.- Major spill, D.- Lost Time Accident, E.- Minor spill, F.- Near miss (significant), G.- Near miss (significant), H.- Major spill)

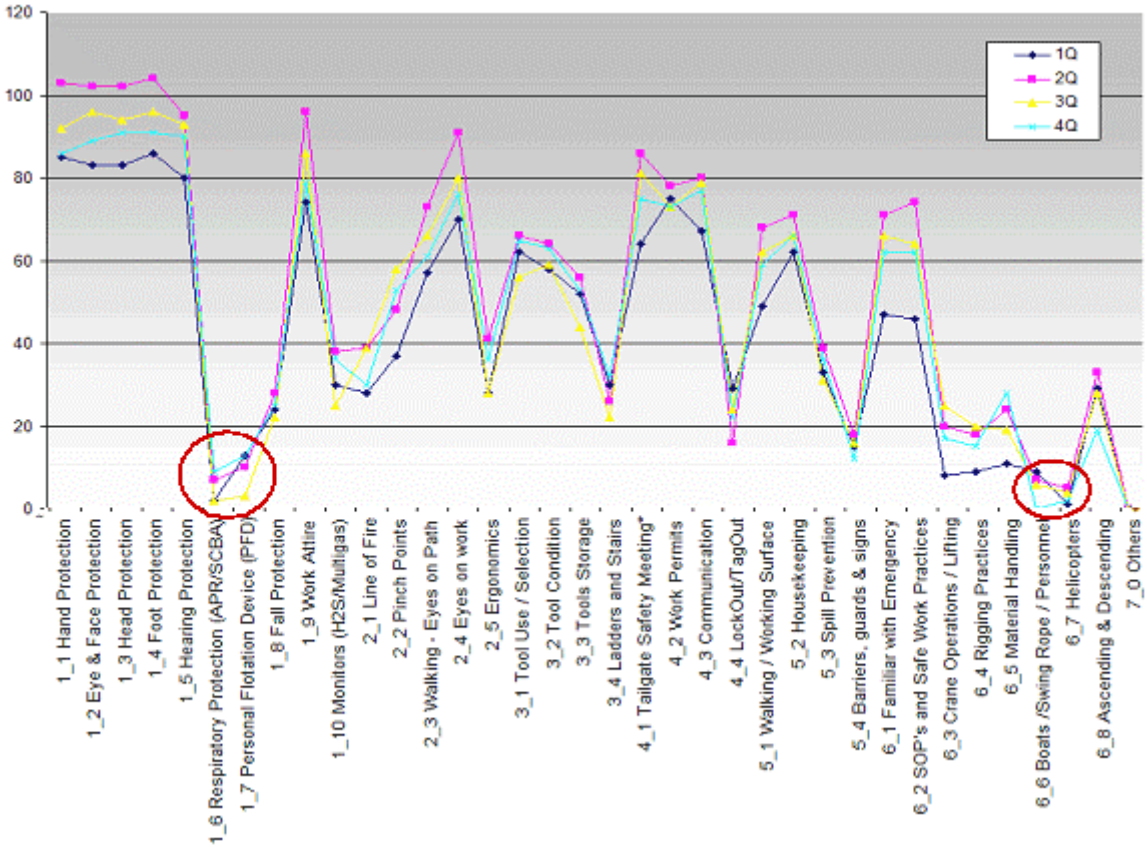


A review of the OWs showed that more than 99% of the observed behaviors were marked as safe with the remaining ~0.44% designated as being "at-risk". At-risk behaviors were distributed approximately evenly among the 36 KSP categories. Changes over time in this percentage were negligible. Examinations of the number of observations per workgroup were unremarkable – Maintenance accounted for the largest number of observations (~33%) followed by Operators (~25%), and Production Field (~10%). Maintenance has more employees than any other department. Similar results were seen for the different facilities/locations at the Takula site – locations with the largest number of workers accounted for the largest number of OWs.

Examination of the number of safe behaviors observed per KSP provides an indication of the relative frequency with which each are observed (Fig. 6). Certain behaviors are rarely observed or checked, for example, very few observation are recorded for KSPs 1.6-Respiratory Protection, 1.7-Personal Flotation Devices, 6.6-Boats, Swing Rope,

Personnel, and 6.7-Helicopters. As mentioned previously, a "hot topic" is selected after a team discussion of those OWs defined as "quality" observations. Based on the way quality observations are defined – those that include a detailed comment on an observed operation - the BASIC program tends to focus and re-focus on topics that the employees know how to observe, discarding those where the training may have never existed or was incomplete at best. The similarities in the observed behavior between quarters as seen in Fig. 7, indicate that no change is occurring over time and that the effort of directing the observation process to a "hot topic" is not working as expected.

Figure 6. Number of safe behaviors observed for each KSP by quarter – KSPs having relatively low numbers of observations circled.



3.2 Quantitative Analysis

When an apparent relationship exists among any set of factors or variables, a quantification of this relationship may be obtained by using regression analysis (Johnson 1949). A regression model is often used to estimate or predict the value of one variable that would correspond with a given value of the other (Rowntree 1981). The most commonly used method is linear regression, but linear regression assumes that the variables are normally distributed and that the variances are all the same between variables (Neter, et al. 1990). In order to avoid the need for complying with these

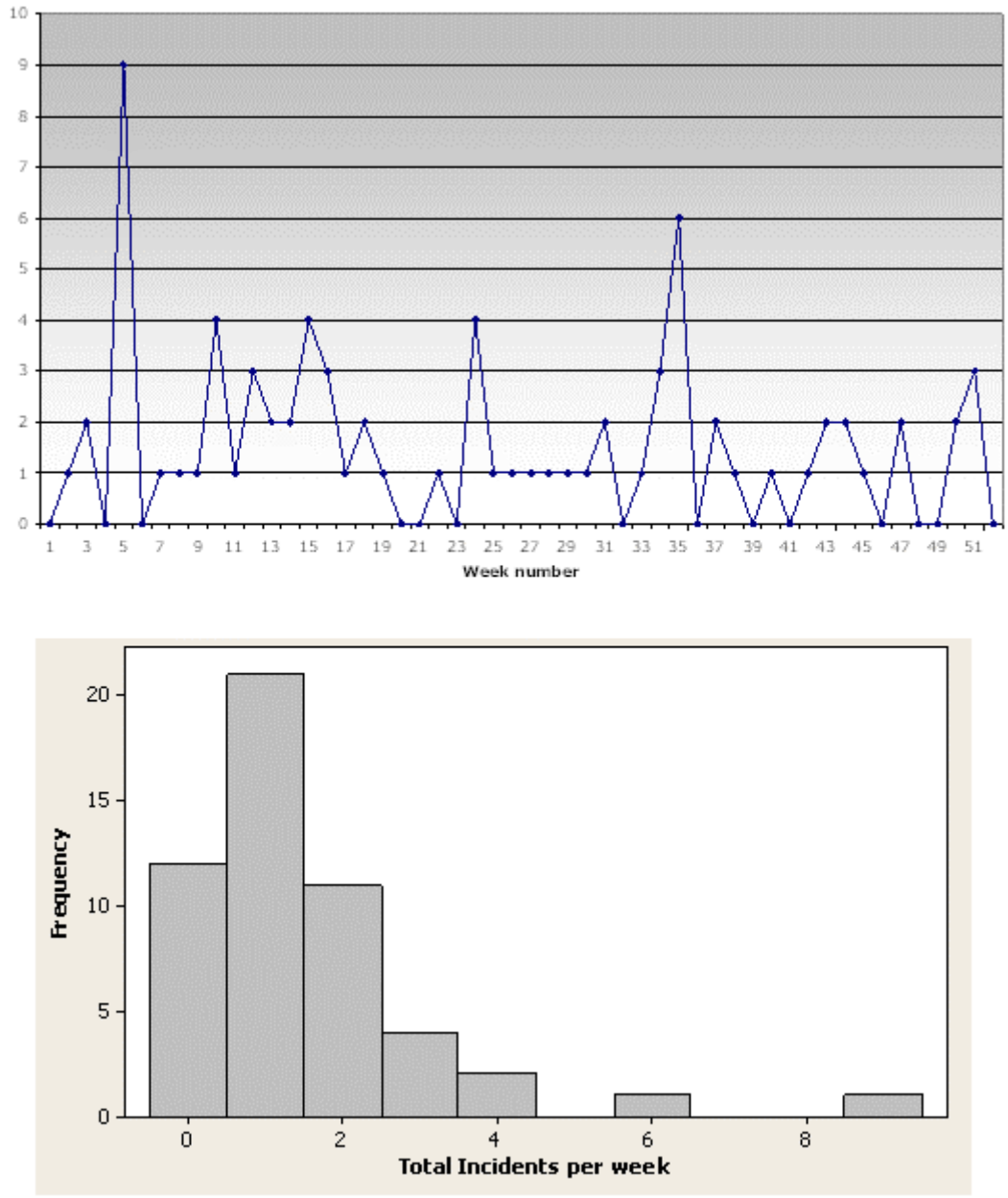
assumptions, an Ordinal Logistic Regression (OLR) model was used. OLR also allows for the possibility of using more than one independent variable as it is intended for this analysis. Using this model, mathematical relationships between the number of daily observation reports, the number and type of behaviors recorded and the four types of incidents – Injuries, Fires, Spills, and Near-Misses – were examined.

The Ordinal Logistic Regression (OLR) model that was used is described in Equation 3:

$$Y = \beta_1 * OW + \beta_2 * \chi_1 + \beta_3 * \chi_2 + ... + error \qquad \text{Equation 3}$$

where Y is an ordinal and dependent variable representing the probability of having an incident, OW is the average number of daily observations, χ_1 is the number of observed "safe" behaviors, χ_2 is the number of observed "at-risk" behaviors, β_1, β_2, and β_3 are the regression coefficients for each independent variable, and *error* is the coefficient α, or disturbance, which may represent the influence of other factors not included in the model. As noted, ordinal variables are expressed as the probability of having an event X, instead of the average occurrence for that event. The criteria used to assign values to an ordinal variable follow: if the number of incidents in a week were zero, the probability was considered to be low (P = 0), if the number of incidents was one, the probability was medium (P = 1), and if incidents in a week exceeded 1 the probability was high (P = 2). Values for the ordinal variables were assigned according to the 2003 incident data represented in Figure 7.

Figure 7. Number of total incidents per week and resulting histogram.



Prior to the final analysis of the data set, the null hypothesis was redefined as: "all coefficients for all independent variables are zero" i.e. there is no relationship between the independent and dependent variables of the model. Table 2 lists the variables examined using the ordinal logistic regression model. Using Equation 3, twenty-four models were evaluated (Table 3). Models were prepared with every dependent variable being tested separately and in combination with the other dependent variables. The main purpose of these different models was to test for Fire and Injury cases. These variables do not meet the criteria of having three different values in the ordinal variable for being

evaluated separately using OLR, but a measure of their impact may be made when tested jointly. The model was run using two commercially available statistical software packages (Minitab® and SPSS®).

Table 2. Variables used in the ordinal logistic regression modeling

Dependent Variables		*Symbol*
Total Incidents		**Y**
Injuries		**I**
Near Misses		**NM**
Spills		**S**
Fires		**F**
Independent Variables		*Symbol*
Observation worksheets		**OW**
Safe Behavior (total)		**X1**
At-Risk Behavior (total)		**X2**
Safe Behavior in		
	Personal Protective Equipment	**S1**
	Body Use & Position	**S2**
	Tools	**S3**
	Job Planning	**S4**
	Work Environment	**S5**
	Safety Procedures	**S6**
	Others	**S7**
At-Risk Behavior in		
	Personal Protective Equipment	**A1**
	Body Use & Position	**A2**
	Tools	**A3**
	Job Planning	**A4**
	Work Environment	**A5**
	Safety Procedures	**A6**
	Others	**A7**

A summary of the results for the analyses is presented in Table 3. From the software output, two values were selected as a measure of significance of the relationships being tested by the model: the P-value and the Nagelkerke R-Square (NCSU 2004). In the log-likelihood test, if the P-value is less than 0.05 the null hypothesis has to be rejected due to the fact that at least one of the coefficients is significant and further analysis must be performed to determine what the strength of the relationship is and which variables are affecting the outcome. All of the models tested (24) resulted in a P-value greater than 0.05, leading to acceptance of the null hypothesis that no relationship exists between the variables. OLR has no widely-accepted coefficient of determination (R^2) that would be directly analogous to that of linear regression. Nagelkerke's pseudo R-square is the most commonly used approximation of a coefficient of determination (R^2) and is used here (NCSU 2004). Values of Nagelkerke's R-square closer to one would represent a strong relationship between variables, while a value closer to zero would represent a non-correlated set of data. The coefficient of determination (R^2) is usually expressed as a percentage of the variability of the dependent variable explained by the model. The

majority of the models in Table 3 explain between 1 -3 % of the variability. The best results achieved is equal to 39.8%, but with a p-value greater than 0.05 this number is not significant.

Table 3. Results for models examined

Dependent Variable	Independent Variables	P-value	Nagelkerke R-Square
Y	OW, X1, X2	0.877	0.015
Y	OW, S1, S2, S3, S4, S5, S6, S7, A1, A2, A3, A4, A5, A6, A7	0.069	0.398
Y	OW, S1, S2, S3, S4, S5, S6, S7	0.576	0.117
Y	OW, A1, A2, A3, A4, A5, A6, A7	0.132	0.241
Y	S1, S2, S3, S4, S5, S6, S7	0.865	0.054
Y	A1, A2, A3, A4, A5, A6, A7	0.089	0.24
Y	S1, S2, S3, S4, S5, S6, S7, A1, A2, A3, A4, A5, A6, A7	0.196	0.298
Y	X1	0.749	0.002
Y	X2	0.822	0.001
Y	X1, X2	0.944	0.003
NM	OW, X1, X2	0.816	0.021
S	OW, X1, X2	0.114	0.128
FNM	OW, X1, X2	0.855	0.017
FS	OW, X1, X2	0.155	0.113
INM	OW, X1, X2	0.713	0.03
IS	OW, X1, X2	0.289	0.08
NMS	OW, X1, X2	0.736	0.027
NMFI	OW, X1, X2	0.705	0.03
NMSI	OW, X1, X2	0.855	0.017
NMSF	OW, X1, X2	0.808	0.021
SFI	OW, X1, X2	0.355	0.07
Y	OW, X1	0.716	0.014
Y	OW, X2	0.743	0.013
Y	OW	0.441	0.013

All 24 models tested resulted in a non-significant relationship. Therefore, no relationship was found between the variables in the statistical model, i.e. the observations from the BASIC program and the incident occurrence were unrelated. This means that neither making more or fewer observations per day, nor observing “safe” or “at-risk” behaviors influenced, either positively or negatively, the incident occurrence. This finding is significant considering the time commitment that performing such observations represents. Assuming the time commitment per observation is approximately 15 minutes and that the daily number of observations ranges from 89 to 349, the time commitment to BASIC ranges from 22 - 87 man-hours per day. This is equivalent to 0.9 - 3.6% of the total manpower for a 12-hour shift at a 200-employee site. This indicates that management may be justified in reevaluating the resource commitment required by BASIC. However, this conclusion does not mean that BASIC may not be improving

other aspects of the organization. Other factors not summarized in the observation process may have a positive but unquantifiable influence on overall safety.

4. Conclusions and Recommendations

No relationship has been found between the observations of the BBS program and the incidence occurrence. Neither making more or fewer observations per day nor observing "safe" or "at-risk" behaviors, influenced either positively or negatively, the incidence occurrence. This finding is significant considering the time commitment that performing such observations represents. However, additional conclusions and recommendations that should improve the BASIC program have been developed as a result of this examination.

4.1 Quality Observations

A quality observation should be defined as one conducted by a trained observer who knows what to look for, how to check for problems, and who has provided feedback to his peers at the end of the observation. The usefulness of the information that can be extracted from the observations relies on the ability and skills of the observer to detect an at-risk or unusual behavior and reflect it in the observation worksheet. Behavior based safety cannot succeed if workers are unable to perceive and recognize hazards in the workplace (Lingard and Rowlinson 1997). If the operator does not understand this responsibility clearly and does not invest sufficient time and effort to capture as much as possible in an observation, the process lacks credibility and the entire process is undermined. Quality observations should be encouraged instead of the quantity of observations to be performed. Quality observations usually take additional time and effort. Therefore, quality observations may help to reduce, in a more natural process, the total number of daily observations developed.

4.2 Hot Topic Selection and Periodic Revision of Observation Worksheets (OWs)

The policy for selecting a "hot topic" should not consider exclusively topics that are described in quality observations, but also those issues or KSPs that are rarely observed as well. A KSP checked less often could mean either that the observers do not know how to observe it and therefore is left blank in the OW, or that the KSP is unnecessary. These possibilities lead to recommendations that a not applicable (N/A) column be added to the OWs and that the list of KSPs be reevaluated and updated on a regular basis. There is no option for indicating that a KSP is not applicable to a particular task. Common practice is to leave it blank, but this method will not distinguish between a situation when the observer decided to leave it blank because he or she is unsure of how to observe that KSP in particular versus when it does not apply to the task. A "not applicable" KSP and a lack of training or exposure to the field are two different things whose solution requires different approaches (Fellner and Sulzer-Azaroff 1984) (Sulzer-Azaroff 1987). The N/A column should be used whenever the observer is sure that the KSP in particular is not related to the task being observed. If an observer cannot decide whether a task should be checked as Not Applicable, Safe, or At Risk, communication with the Person In Charge may resolve the question. BASIC will have benefited from a better communication

between observer and the observed. If this communication is insufficient or useless, the KSP should be left blank and the BASIC team will know that there is an area of opportunity to train or talk about a potential "hot topic" for the week.

Keeping the BASIC program responsive and relevant is a continuous responsibility of everyone at the site - it is a well recognized characteristic of BBS programs that the approach is not self-sustainable (Judi Komaki, et al. 1978) (Chhokar and Wallin 1984) (Geller 1980) (Hickman and Geller 2003) (Komaki, et al. 1980). One part of maintaining the BASIC program should be a process for updating the KSPs. In addition to including the N/A column as suggested, there may be KSPs that are always checked as "Safe". This probably means that a "safe" behavior in that KSP is now an accepted practice. In the case of those KSP that are always checked as N/A, there is no reason to retain that item unless it is derived from a major potential hazard that is rarely present. On the other hand, an injury or near-miss may bring to light an important issue that is not included in the OW. The decision process of deleting or adding KSPs can only be made by the BASIC team on site. If the form is updated, refreshment training for all users may be required. Further, all changes to the OW and the timeframe in which a KSP is counted should be recorded (Geller 1991).

4.3 Safety Balance

It appears that that many safety-related issues are not being observed or corrected through the BASIC process and the use of observations alone, especially after considering the results of the quantitative analyses presented here. Hazards that are addressed through inspections under the Preventive Maintenance Program, in training, or as a result of other important safety initiatives on site contribute to the safety metrics. These programs should be given recognition and visibility similar to that of BASIC, so that employees commit to the same level of active participation as seen for BASIC.

Acknowledgements

The authors gratefully acknowledge the support of Penn State's Alliance for Earth Sciences, Engineering and Development in Africa (AESEDA), and Dave Willey, Platform Superintendent.

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