DOE HANDBOOK

THE DEPARTMENT OF ENERGY
BEHAVIOR BASED SAFETY PROCESS
Volume 1: Summary of Behavior Based Safety.

U.S. Department of Energy
Washington, D.C. 20585

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Foreword

This non-mandatory Standard is designed to assist Department of Energy (DOE) and contractor managers in implementing of behavior based safety processes and are approved for use by all DOE Components and their contractors.

The best practices outlined in this technical standard are the culmination of much effort by the Department of Energy (DOE) for assuring the successful implementation of behavior-based safety.

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INTRODUCTION

This handout presents a description of the Behavior Based Safety (BBS) practices as individually developed at several Department of Energy (DOE) facilities. It is meant to be a resource of best practices, which can assist sites in implementing or improving BBS.

The BBS Topical Committee, sponsored by the DOE through the Technical Standards Program recognized the need for a BBS Handbook. A working group composed of both DOE and contractor members developed the Handbook for general guidance. It is not to be interpreted as all-inclusive, however is published to provide a framework to consider as contractors consider and/or implement BBS. As in any such implementation, a site’s culture will impact how and when to institutionalize new paradigms. However, there are key fundamentals to the behavioral approach to safety, and these should not be violated.

More information can be obtained from the BBS Topical Committee Web-site:

http://tis.eh.doe.gov/bbs/
1.0 Overview of Behavior-Based Safety Process

1.1 Background of Behavior-Based Safety (BBS)

Behavioral science traces its inception to a merging of different fields of science: a medical doctor who held a university chair in Philosophy in 1876. BBS brings together parts of behavioral science with industrial safety to create a “new” process to promote safety as an organizational value.

In 1951, Heinrich reported that about 90% of all accidents were caused by “unsafe behavior” by workers. Subsequent studies by DuPont (1956) confirmed Heinrich’s contention. Traditional engineering and management approaches to counter this, such as automation, procedure compliance, administrative controls and OSHA type standards and rules were successful in reducing the number of accidents significantly. There was however, a persistence of incidents and accidents that kept rates at a level that was still disturbing to customers, managers, and workers.

Developed in the late 1970s, behavior-based safety has had an impressive record. Research has shown that as safe behaviors increase, safety incidents decrease. Measurement of percent safe acts is a leading safety indicator. In contrast most safety measures are lagging measures. They are recorded after the incident (e.g. OSHA recordable cases).

There is also ample anecdotal evidence of percent Safe Acts being predictive. In some cases, the changes in the rate were acted upon, stopping the unsafe trend. In some cases the trend was not acted upon and an accident happened within a short period of time. Connelly (1997), who worked with the DuPont BBS process, claimed that DuPont felt that a change in the Safe Acts Index (% Safe Acts) was a three-week predictor of an accident.

This means that the observation and feedback techniques of BBS may be used to predict that safety problems may be growing in your facility. Intensifying the BBS observation cycle will often prevent an injury or accident.

1.2 Behavior-Based Safety in DOE

Within the DOE, there are a growing number of BBS processes. Each one has its specific orientation and techniques. Despite these variations, all BBS processes
have four major components: 1) investigation of the antecedents to at-risk behavior, 2) the observation process, 3) action plans to influence at-risk behaviors and conditions, and 4) feedback.

Within the DOE, BBS has been instituted at sites such as the Savannah River Site (SRS), Pantex, the Strategic Petroleum Reserve (SPR), and at national laboratories such as Los Alamos National Laboratory (LANL), Idaho National Engineering and Environmental Laboratory (INEEL) and Lawrence Berkley National Laboratory (LBNL). In all cases, implementing the behavioral safety process has led to an increase in safe behaviors and a decrease in overall safety incidents.

Over the years, the DOE has had an excellent safety record compared with much of industry, but there is still concern by oversight boards such as the Defense Nuclear Facilities Safety Board and Congress about the number and nature of safety problems in the DOE complex. Within the DOE, as shown by the incident data in the Occurrence Reporting Processing System (ORPS), personnel error from all sources is present in over 77% of all occurrences. Instituting programs such as the Integrated Safety Management System (ISMS) and the Voluntary Protection Program (VPP) has been part of the continuing responses to this persistent safety problem. Within this context, several DOE sites have looked to BBS to reduce the human error aspects of safety.

Figure 1. Causes present in the DOE’s Occurrence Reporting System (ORPS) Reports (1999-2001)
The core philosophies of the BBS approach are complementary to many of the existing programs within the DOE. For example, BBS supports VPP and ISM by giving an avenue for employee involvement and a systematic approach to identify and correct behaviors and conditions that lead to employee injuries.

BBS applies to a broad range of safety areas. BBS can be promoted on the production floor, or in the office, and is applicable off the job as well. BBS enhances several historic programs (e.g. management tours, housekeeping audits, and ineffective safety meetings), thereby reducing the overall safety program cost. This indicates a shift in the focus of safety from programmatic to an “on the shop floor” focus. Organizations that properly implement BBS see the return on the investment (“ROI”) of spending safety resources directly in the active work area, and this also leads to “Reduction of Injuries”. This adds value to safety meetings and management tours, which customarily focus on conditions.

1.3 Benefits of BBS

BBS is a process that provides organizations the opportunity to move to a higher level of safety excellence by promoting proactive responding to leading indicators that are statistically valid, building ownership, trust, and unity across the team, and developing empowerment opportunities which relate to employee safety. Secondly, but equally as important to the organizational culture, BBS provides line management the opportunity to prove and demonstrate their core values on the production floor.

BBS used in the context of the DOE’s Integrated Safety Management, impacts injury rates and Total Reportable cases. The safety literature and DOE experience show that this occurs with consistency as shown in Figure 2. This shows the Total Recordable Case (TRC) rate from seven different sites using BBS. In each of the cases, the TRC rate was lower following BBS implementation than before BBS.

It should, however, be noted that multiple facets of an organization influence the swings of injury rates. When a statistical process control perspective is applied, an organization realizes that specific fluctuations will occur, however the process will remain “in control”. BBS is “a key on the key ring” of safety. It is neither a quick fix nor a silver bullet. It is, however, an important process that addresses the human element of industrial safety in a scientific, logical approach with leading and predictive indicators.
Other safety measures also are affected by BBS. The Los Alamos National Laboratory has reported that the Radiological Incident Rates for two facilities were reduced significantly with a BBS process in place (Figure 3).

A properly designed BBS process will involve workers from every level. The atmosphere of trust that results from the non-punitive observation and feedback process leads to more worker involvement. Workers frequently start asking to be observed and they use the feedback given to modify their activity to make themselves and their fellow workers safer. The rapport that slowly develops between the observers and the workers being observed leads to a more open workplace. As trust increases, the reporting of minor incidents increases, yet severity typically declines.
Figure 3. Changes in Radiation Incident rates at Los Alamos National Laboratory before BBS and after BBS implementation.

BBS is good business. Safety costs money, safety programs take manager and worker time, and incidents take time to investigate. The data from LBNL, SRS and SPRO shown in Appendix C reflects how BBS can save money. The observation process is also transportable to improving the way work is done, which can lead to enhanced quality.

BBS values, such as building trust, sound relationships, leading indicators are applicable in all business activity. Once an organization becomes fluent in leading the safety process through a behavioral approach, it can transfer this experience into other business priorities, such as customer service, quality and absenteeism, making the implementation a spearhead to many business improvements.

2.0 BBS Overview

Linking behavior to hazardous situations is not new. In 1876 a medical doctor who held a university chair in Philosophy developed a behavioral science theory. Behavior-Based Safety brings together parts of behavioral science with safety knowledge to create a “new” process.
As early as the 1950s, Heinrich (1951) reported that “unsafe behaviors” were linked to about 90 percent of all accidents. Subsequent studies by DuPont (19) confirmed Heinrich’s contention. Traditional engineering and management approaches tend to center around controls focused on automation, procedure compliance and administrative controls. These, and OSHA-type standards and rules, were successful in significantly reducing the number of accidents. But, despite these actions, incidents and accidents kept rates at unacceptable levels. Within DOE, data in the Occurrence Reporting Processing System (ORPS) shows personnel error is still present in over 77 percent of all occurrences. The DOE’s Integrated Safety Management System (ISMS) and Voluntary Protection Program (VPP) are part of the continuing responses to this persistent safety problem. However, several DOE sites are also looking to behavioral solutions to reduce the human error aspects of safety.

Formally developed in the late 1970s, behavioral safety has an impressive record. Research shows that as safe behaviors increase safety incidents decrease. Within the DOE, production facilities such as Pantex, the Savannah River Site (SRS) and the Strategic Petroleum Reserve (SPRO), and national laboratories such as Los Alamos National Laboratory (LANL), Idaho National Engineering and Environmental Laboratory (INEEL) and Lawrence Berkley Laboratory (LBL) have instituted behavioral safety. In all cases, implementing the behavioral safety process has led to an increase in safe behavior and a decrease in overall safety incidents.

Most behavioral safety processes are tailored to the work and management environment of the site. Despite these variations, all behavioral safety processes have three major components:
1. Development of a list of at-risk behaviors,
2. Observations, and
3. Feedback.

This handbook will provide a description of the basic process of setting up and running a behavioral safety program and give some variations that have worked in different sites around the Department of Energy.

The process starts with a behavioral hazard analysis to identify at-risk behaviors. These can be determined using accident/incident reports, Job Hazards Analysis, employee interviews and brainstorming. In some instances a combination of all these tools could be used. Using the at-risk behaviors, a checklist is then developed to assist in the observation of work behavior. In addition, a list of corresponding behavior definitions is helpful in maintaining consistency between observers and the resulting data. Observers record safe and at-risk behaviors on the datasheet and provide feedback to workers about their performance. This feedback reinforces the necessity for safe behaviors.
The observation data is used to identify barriers to safe behavior. Removing these barriers lowers the workers’ exposure to at-risk conditions and makes it easier for employees to work safely. Removing barriers and communicating successes increase employee involvement in the process. Many of these employees take these tools home, which helps decrease off-the-job injuries.

3.0 BBS & ISM Functions

DOE sites have embraced ISM as a philosophy for years. They have implemented ISM as it applies to specific work and tasks. A successful BBS process by default or design encompasses the Seven Guiding Principles of ISM. These principles provide the foundation on which any BBS process should be built. BBS enables organizations to apply the Five Core Functions across the entire organization, on a day-to-day basis and does not restrict the process to the actual performance of work. Many of the injuries in the workplace occur when employees are involved in non-task related activities such as walking from point A to point B. BBS processes also provide the footprints to show that ISM is at work around the clock.

3.1 SEVEN GUIDING PRINCIPLES of ISMS

1. Line Management Responsibility for Safety
   The responsibility for safety and the BBS process is shared by management and front-line workers. All levels of the organization are involved in an effective BBS process.

2. Clear Roles and Responsibilities
   Functions within the BBS process are performed at the proper level and are integrated and adapted to fit the formal organization itself.

3. Competence Commensurate with Responsibilities
   An effective BBS process provides the skills needed to perform the tasks and functions associated with the job in a timely manner; the opportunity to use those skills on a regular basis; and provides for coaching and interaction with other people and organizations using the BBS process.

4. Balanced Priorities
   BBS provides the consistent stream of safety data that enables managers to balance safety priorities with production and other operational needs.
5. Identification of Safety Standards and Requirements
Existing Safety standards and requirements aid in developing the list of behaviors and definitions used in the BBS process.

6. Hazard Controls Tailored to Work Being Performed
The observation process provides ongoing monitoring of processes so that Hazard Controls reflect the risks associated with work being performed in changing environments and conditions.

7. Operations Authorization
The BBS process helps provide the behavior-related safety information necessary to make informed decisions prior to initiating operations.

3.2 Five CORE FUNCTIONS of ISMS

- Define the Scope of Work
Sites developing and maintaining a Behavior-Based Safety process must use several steps to define the scope of the work:

  - Form assessment team(s)
  - Extract behaviors that were involved in past accidents/incidents
  - Developed definitions that describe the safe behavior
  - Compile datasheet using identified behaviors
  - Determine observation boundaries
  - Train observers
  - Gather data
  - Determine barrier removal process
  - Form barrier removal teams

- Analyze the Hazards
Analyzing hazards is built into the BBS process. Hazards are being analyzed during each observation and the worker observed receives immediate feedback on how to minimize the risk. The assessment team and barrier removal team analyzes the data gathered through observations to determine workplace hazards. The teams then develop action plans to remove barriers to safe work.

- Develop and Implement Hazard Controls
Employees tasked with planning or designing work can also use the behavior assessment and data. By studying the definitions and data,
barriers that could require a worker to perform at-risk behaviors can be designed-out up front. This fore thought makes the workplace a much safer environment.

- **Perform Work Within Controls**
  Although work has been designed and training conducted to help the employee know how to work safely, bad habits and shortcuts can introduce at-risk behaviors into the workplace. The ongoing observation process encourages the continued use of safe behaviors and reminds workers that one at-risk behavior could cause an accident, injury or even a fatality.

- **Provide Feedback and Continuous Improvement**
  Feedback is provided each time an observation is performed. The feedback process reinforces the use of safe behaviors and helps determine why certain at-risk behaviors were performed. Collecting information about the at-risk behaviors helps the teams determine the root cause of a behavior and develop an action plan to remove the barrier causing the behavior.

### 4.0 Establishing a BBS Process

### 4.1 BBS Readiness

All aspects of BBS may not work in every organization. There is plenty of resistance to programs that promise big benefits but only result in more paperwork, less progress and a mountain of wasted time for safety teams. Although it's no magic bullet for injury prevention, there is data to prove that as observations go up, injuries go down. The question is: "Will it work for your company?" The promises of BBS results are not empty ones, but your company has to be ready.

However, like any other prevention program, the conditions need to be right. Management support, effective management systems and company culture are keys to determining whether or not a company is ready for a transition to BBS. Since implementation of these processes can be costly, how can one tell whether a company is ready for it?

There are five conditions that dramatically increase the likelihood of success:
• Safety Leadership;
• Established Integrated Safety Management System;
• Employee Empowerment and Participation in Safety;
• Organization’s Safety Culture;
• Measurement and Accountability.

4.1.1 Safety Leadership
Leadership must be active, visible and genuine in their commitment to injury and illness prevention. It is helpful for senior management to articulate a clear and inspiring vision that injury-free performance is the only acceptable goal. However, caution is needed here. These “vision messages” can be interpreted as “don’t report injuries” as a method to achieving a goal. The organization must view safety as a core organizational priority equal to research, operations, productivity and quality.

4.1.2 Established Integrated Safety Management System
In order for BBS to be effective, an integrated safety management system needs to be in place. This includes minimum compliance, accident investigation, self-assessments, safety and health training program and record keeping systems. More advanced systems enhancements like observation, coaching, safety involvement teams, job safety analysis, accountability, and safety by objectives all rely on the basics being in place.

4.1.3 Employee Empowerment and Participation in Safety
Employee empowerment and involvement enhance safety innovation, ownership and results. Labor/management cooperation serves as a catalyst for success. Without employee participation and involvement BBS won’t get off the ground. Another critical facet of involvement is buy-in. Behavioral systems are much more effective in organizations that work hard at winning buy-in from the line to the executive office before they are introduced.

4.1.4 Organization’s Safety Culture
A positive social climate of trust, openness and respect for individuals is an intangible of organizational life that dramatically affects worker performance. With a more negative organizational style involvement is low, complaining replaces problem solving and coaching seems like scolding. In companies low on trust, BBS is resisted because it symbolizes another way to oppress the worker.
3.1.5 Measurement and Accountability

**What gets measured gets done.** Clearly defined responsibilities at every level of the organization are the start points for top performance. When performance evaluations include safe and at-risk behaviors, strategies can be developed to focus on real threats to worker safety.

### 4.2 Setting up the BBS Process

BBS processes should be tailored to the work and management environment where they function. Initial work in setting up a BBS process should include management, workers and the union at your facility. A major player is the “champion” who has the responsibility for initially driving the process forward and guiding initial training and the initial selection of the steering committee.

#### 4.2.1 Establishing a Steering Committee (SC)

The SC is the cornerstone for the implementation and growth of the BBS process in an organization, as it sets the boundaries for the process and guides the development, implementation and process continuation. The initial Steering Committee is selected from a group of qualified employees, preferably volunteers, representing each distinct group, team, etc. of the organization. The SC should be kept to a manageable size of around ten to fifteen members. If the SC is larger, it may not function as well. Therefore, multiple committees may be necessary. This decision may have negative consequences if not well managed. The SC should determine how new members will join. The SC is composed of employees from the facility or organization, and should be a diverse cross section of the organization. It is equally important that the personnel selected from the volunteers be those who command the respect of their peers, display leadership qualities, and are forward thinkers.

The organization’s manager, BBS coordinator and the management champion may make initial assignments to the team, and should establish the duration of the term, which is typically one year.
4.2.2 SC Roles and Responsibilities

The functions listed below have been determined to be key to the successful workings of the SC and to guiding the organization through implementation. The functions may be combined based on the number of members available and the capabilities of those individuals.

Management must recognize that the implementation and growth of the BBS process requires time and resources. Personnel must be afforded the opportunity not only to serve on the SC, but also to adequately perform assigned functions within that body. Each of the following functions describes the responsibilities, desired characteristics or abilities, and highlights the expected time factor (TF) involvement (Hi, Med, and Lo) for that position.

- **Management Champion/Sponsor** – The management champion or sponsor serves as an enabler and resource for the material needs of the SC. This individual must be a high-ranking member of management with a devotion to the BBS process. The individual must be willing to accept a role as equal on the SC, and avoid the temptation to manage the team. (TF=Lo to Hi)

- **Facilitator** – This individual should be a strong supporter of BBS, be knowledgeable of the process, and be an energetic leader comfortable with working within the organization’s environment. This person leads the team through the BBS process implementation. Strong consideration should be given to selecting a deputy or assistant Facilitator, for both continuity and depth of leadership. Functions include:
  - BBS Process Expert
  - Have a vision of long term process sustainability
  - Liaison with management team
  - Action plan coordination
  - Meeting chair
  - Training and monitoring observation performance
  - Other functions as identified by the SC and sponsor, such as data administrator and data input. (TF=Hi)

- **Data Administrator** – The data administrator will be responsible for data analysis, or assist the facilitator with this function. Access to the data will be necessary by various individuals. Access to the database should be
controlled. This function will require some computer experience. (TF=Lo to Hi)

- **Data Entry** – In organizations using a single data entry point, this function should be associated with the SC. If a single data entry point is used, this person will input all completed observation forms into an observation database. This necessitates good typing skills and a flexible schedule. This task may be performed by committee members or clerical support. (TF=Lo to Hi)

- **Data Manager** – In order for injuries and accidents to be predicted, the data gathered through observations must be reviewed and interpreted. The Data Manager prepares data packages for SC review, posts appropriate graphic information on organizational bulletin boards, provides necessary statistical information, etc. An additional desirable quality would be that of statistical analysis ability to help the SC interpret the data. (TF=Med to Hi)

- **Recording Secretary** – This function records SC meeting minutes, prepares and issues the minutes, and upcoming agenda prior to next meeting. The timely issue of the meeting minutes requires the ability to do a quick turnaround. The recording secretary needs good organizational skills. (TF=Med).

- **Communicator** – Experience in BBS implementation has determined that communications plays a pivotal role in the involvement of the observer force and the education of the organization. This function provides for release of information from the SC to the observer force and the organization. Desirable qualities in an individual filling this function are creativity, flexibility, computer skills and good oral and written communication abilities. (TF=Med)

One final factor for consideration is the level of involvement that the organizational safety engineer(s) will have with the SC and the BBS implementation. The SC may choose to include a safety Engineer on the team. Safety engineers should be trained in the observation process along with other observers.

The SC should fill these positions, as they deem necessary for the success of their process.
4.2.3 The Function of the SC

Basic responsibilities of the SC are:

- Develop the at-risk behaviors inventory
- Participate in the training and coaching of observers to provide for mentoring the observer process
- Design the Observation Process
- Analyze the observation data
- Build Action Plans to respond to the leading indicators seen in the data
- Ensure communication with observers is maintained
- Ensure BBS is promoted and communicated to all organizational levels.

The SC may elect, as part of their team building efforts, to create an identity for the team or for their organization’s process. A unique name or acronym, logo, motto or slogan can serve as a rallying point for the team. Depending upon the implementation, this identity may be site wide, or facility based.

4.3 Identifying At-Risk Behaviors

A very important step is the development of a list of at risk behaviors. This inventory is supported by list of definitions and examples of critical behaviors based on information extracted from injury reports, interviews and observation of ongoing task native to a site’s work environment. This inventory of behaviors, customized for your facility, is the basic tool of observation. The observation data will ultimately be used to develop plans for risk reduction. Customizing the inventory is also critical in promoting acceptance and ownership of the process by the employees.

The behavioral definitions and examples should be written so that they are “observable”. Critical behaviors should be organized by risk factors, and in order of their potential severity.

3.3.1 Resources utilized for extraction of critical behaviors:

- Accident/Incident Reports: Information extracted the investigations will indicate behaviors that have placed employees at risk for injury in the past. Review of these reports will often result in more than one critical behavior contributing to an injury or incident. The SC should be involved
in current and future investigation groups to maintain good continuity of information from a behavioral perspective.

◊ Job Safety Analysis, Job Hazard Analysis, and PPE Assessments – Personnel who are deemed to be working closest to the risk generate these documents. Information derived from these documents will assist in determining hazards on a “task to task; step by step” basis for SC members who may not be familiar with certain jobs.

◊ Task Observations- Conducting observations of typical work tasks will not only validate behaviors that have already been extracted from historical sources, but may also reveal a new critical behaviors. There may be critical behaviors to be discovered that have not resulted in recordable injury. Observations can also provide a means of engaging employees in the development of the site process.

◊ Employee Interviews- Interviewing employees from various work groups can provide an opportunity for workers to explain how they perform their jobs safely. Knowing what behaviors are used to perform jobs safely can aid in determining the risks of not performing a job in a behaviorally safe manner.

◊ Brainstorming- Group interviews can help identify critical behaviors in work teams, which have historically low injury rates and low risk perception.

4.4 Review and Revision

Maintaining a valid inventory is critical to continuous improvement. The inventory should be reviewed periodically (at least annually) for applicability by the steering committee. Observers also review the tools during routine observations. New at-risk behaviors may be identified, especially when new equipment, facilities and processes are introduced. Some behaviors may not be currently valid because the tasks associated with them have been changed or are no longer contributing to risk. These may need to be retired from the inventory. Inventories are modified by a combination of data, and the informed judgement of the steering committee.
APPENDIX A

DATA COLLECTION and SAMPLE CHECKLIST
Safety Improvement Process  (WSRC)

Collect Data

Complete Checklist

Feedback

Observation

Local Safety Improvement Team

Improve Safety Process

Safety Observation and Feedback Process

1. Introduce yourself, ask their name, put the person at ease and explain the process. Ask permission to do an observation.
2. Ask the person to explain the job that is being performed.
3. Ask them to define the hazards and precautions associated with the task they are performing.
4. Ask open-ended questions to learn more about at-risk behaviors. (Ex: What’s the worst accident that can happen? How could you be hurt doing this task? Why are you doing it this way?)
5. Observe the job.
6. Provide positive feedback by praising safe behaviors first.
7. Draw out the corrective action that may be required from the person.
8. Get a personal commitment that the individual will carry out this action and thank the person for participating. 4/30/02
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<th>Barrier Number</th>
<th>CBI #</th>
<th>Agree</th>
<th>Follow-up</th>
<th>Written Comments (No names) REQUIRED for all at-risk and miscellaneous behaviors.</th>
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<td>10.10 Best Practices</td>
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**Use this space to document any Best Practices observed. These will be further discussed in next months Safety Meeting.**

**Critical Behavior Inventory Definition Reminders**

1.1 Eye & Face Protection - wearing proper eye and face protection for the task (glasses, face shield, goggles).
1.2 Hand Protection - proper gloves (high voltage gloves, rubber gloves, galant style).
1.3 Body Protection - proper protective clothing (acid suit, steam suit, rubber apron) including seat belts.
1.4 Foot Protection - proper foot protection (safety shoes, boots).
1.5 Fall Protection - properly protected from falling when working where this hazard exits (safety harness, tie-offs).
1.6 Hearing Protection - wearing proper hearing protection where the hazard exists (ear plugs, ear muffs).
1.7 Head Protection - hard hat worn appropriately where hazard exists.
2.1 Line of Fire - worker is positioning his body to avoid injury by any moving hazard (reflected arcs, escaping steam, falling objects).
2.2 Lifting - proper lifting techniques (using legs, back straight, weight close to body, feet flat on floor, knees bent).
2.3 Pinch Point - aware of and avoid pinch points (pinch points blocked, maintaining body parts out of pinch points).
2.4 Awkward Position - proper body mechanics (over-extended, using legs not back when pulling).
3.1 Tool Use / Selection - using the right tool for the job and using it properly (correct style wrench, opening only one drawer at a time).
3.2 Condition - tools, even if correct for the job, must be in good condition (electrical cords properly insulated).
3.3 Position Parked - vehicle is left in the position which creates the least possibility of incident (back before parking).
3.4 Ergonomics (Design) - system / component designed to be user friendly, with the operator(s) in mind (accessible, low strain).
4.1 Eyes On Path - watching what you are doing and where you are going (looking for / being aware of hazards).
4.2 Eyes On Hands - aware of hand placement (watching where hands are placed during work or near hazard, not being distracted).
4.3 Ergonomics (Design) - system / component designed to be user friendly, with the operator(s) in mind (accessible, low strain).

**BARRIERS**

1. Training Issue - Unfamiliar - never trained, unqualified, too long since training, unusual task.
3. Apathy, Insignificant - don't care, unimportant.
4. Facility and Equipment Condition - design, malfunction or deterioration contributing to at-risk condition or behavior.
5. Disagreement on At-Risk Practices - can't agree that an at-risk condition or behavior exists.
6. Personal Factors or Distractions - not thinking, mind not on the task at hand, pre-occupied, self imposed pressure.
7. DELETED
8. Accepted Culture or Peer Pressure - doing the wrong thing because our peers do, going along with the crowd, rather not "rock the boat".

Please call any of the ZAPP Leadership Team for additional understanding of this form or if you have suggestions for improvements.

Additional copies of this form can be obtained from SUD’s Home Page on ShRINE.
APPENDIX B

Reinforcement Theory and Behavioral Safety
As early as 1885, Ebbinghaus noted that performance improvement occurred in learning with feedback about answers. Thorndike (1898) noted that learning, a positive change of behavior, proceeded with reinforcement. In the following decades, these findings were amplified and refined by research by Pavlov (1927)\(^1\) and Skinner (1930\(^2\), 1938\(^3\)). It was not until 1950 when Dollard and Miller\(^4\) first suggested that this reinforcement process be used to change behavior of people, in a clinical psychology setting. Skinner suggested (1955) in his novel Walden II that this process could be used to shape society. Within a decade, “behavior modification” was being used by psychotherapists all over the country. In 1971, Skinner published “Beyond Freedom and Dignity” where he suggested that a “technology of behavior” could be used to correct many problems caused by “poor” human behavior in society. The technology of behavior was first applied to the problem of correcting “unsafe behavior” by Komaki and her associates in 1978.

In 1978, Komaki, Barwick and Scott first applied reinforcement theory to the problem of safety. They showed that behavioral observation and feedback could effect behavior; an increase in safe behaviors from 75-80% to 95-99% was found. The feedback given was positive, which elicited positive reactions from the employees as well as their supervisors. Komaki et al. demonstrated a positive impact on safe behaviors, but the initial study did not link this increase in safe behaviors to actual safety measures. Sulzer-Azaroff (1978) and Sulzer-Azaroff and Santamaria (1980) demonstrated that when safety hazards are identified, and positive feedback is used following hazard inspections, the number of hazards is reduced. The implication is that the fewer the hazards, the safer the workplace. It was left to Reber and associates (Reber, Wallin & Chhokar, 1983; Reber & Wallin, 1984) to relate safe behaviors to different safety measures. They found the correlation with the overall injury rate was \(r=-0.85\) with a lost-time injury rate of \(-0.69\). The negative correlation indicates that as the percentage of safe behaviors increase, injuries decrease. A 1993 survey offers a comparison of different safety interventions as shown in Figure 2 (Guastello, 1993). Guastello

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presented his data in terms of percentage injury reduction and reported the effect of such traditional safety interventions as engineering (29% reduction), management audits (19%), poster campaigns (14%), near miss reporting (0%), but reported 51.6% due to "comprehensive ergonomics" (European definition) and 59.6% due to behavior modification (behavioral safety). It appears that the behavioral safety approach is attacking a different aspect of the safety problem.

Figure 2. Percent injury reduction due to different safety program interventions. (Guastello, 1993)
APPENDIX C:

SITE EXPERIENCES.
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A. Lawrence-Berkeley National Laboratory

Table 1. Lawrence-Berkeley National Laboratory BBS amortization

<table>
<thead>
<tr>
<th>Metric</th>
<th>Result</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Payback Period</td>
<td>0.6 years</td>
<td>Recovered $230,000 in BBSP program costs within 7.2 months.</td>
</tr>
<tr>
<td>Net Present Value</td>
<td>$648k</td>
<td>Generated $648,000 in lost prevention savings from BBSP implementation (50% from workers compensation program)</td>
</tr>
<tr>
<td>Return on Investment</td>
<td>281%</td>
<td>Created an investment return from BBSP that nearly triples the initial program outlay of $230,000</td>
</tr>
</tbody>
</table>

The costs included in this data included:

- EH&S Division’s personnel time for developing the BBAP program and investigating SAARs
- BBAP software development for tracking and trending metrics
- Retaining a consultant from Behavioral Safety Technology (BST) to certify LBNL’s BBAP program
- Purchase of BBAP videos for training coaches
- Creation of BBAP critical behavior checklists/field booklets
- Sending LBNL employees to BST Users Conference
- Coaches Training
- BBAP Committee Meetings
- Field Observations by Coaches
- BBAP Coaches’ meetings
B. Westinghouse Savannah River Company

Data from SRS-SUD shows that costs recouped from the improved safety due to BBS can be significant.

Table C-2. TRADITIONAL SAFETY vs. BEHAVIOR-BASED SAFETY PROCESS

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<tr>
<td>Number of Personnel</td>
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<td>TRC RATE</td>
<td>2.44</td>
<td>0.74</td>
<td>-1.7</td>
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<td>SAFETY COSTS</td>
<td>$543,200</td>
<td>$435,813</td>
<td>$107,383</td>
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SAFETY COST ITEMS

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<td>Safety Meetings</td>
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<td>Awareness Programs (Safety Activities Team)</td>
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<td>Awareness Programs (Safety Suggestion Team)</td>
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<td>Awareness Programs (Housekeeping Team)</td>
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<td>Awareness Programs (Safety Observer Team)</td>
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<td>Safety Observer Audits</td>
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<td>Safety Stand Down</td>
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<tr>
<td>Accident Cost (&quot;x&quot; per accident)</td>
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<td>Observer Refresher (Senior)</td>
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<tr>
<td>Accident Investigation</td>
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<td>Workman's Compensation (&quot;y&quot;)</td>
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<td>Observer Training (Basic)</td>
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C. Dyn-McDermott at the Strategic Petroleum Reserve (SPR)

The Cost Index is one of the five performance metrics from the Occupational Safety and Health Administration (OSHA) used DOE-wide in judging the effectiveness of Integrated Safety Management performance.

• This is an artificial rate used for comparison of accident costs. It is arrived at by assigning certain categories (death, permanent disability, etc.) a dollar value – it does not reflect actual insurance payments, for example.

• Looked at on a month-by-month basis, the SPR’s Index peaked in June of 2000 at over $25.00. Since then there have been 10 months with no injuries or illnesses, driving the rate down to less than $3.00 for the last six-month period.

**Note.** These figures exclude a vehicle fatality, November 2000, where a private vehicle crossed the I-10 median and hit and killed an SPR employee driving a Government vehicle in the other direction. OSHA did not investigate or assign
any blame to the SPR employee. The only reason the accident was considered work related was that he was returning from one of the sites. Including the fatality would add a factor of 1,000,000 to the initial equation.