Practical Injury-Rate Goal-Setting

Formula helps SH&E professionals measure and promote safety improvement

By Pat L. Clemens

As early as 1939, it was noted that continued failure to achieve a defined goal leads to demoralizing frustration and despair (Dollard, et al). Such an outcome can only be expected to blunt the goal’s effectiveness as a motivator.

Continued failure to achieve a goal of zero brings with it temptations to underreport injuries and falsify injury records. Were such temptations not prevalent, government regulations would not need to prescribe penalties for misrepresenting injury data, nor would infractions of those regulations be so commonplace (OSHA).

Irrefutable mathematics present the greatest argument. Probabilists have long recognized that among a population of postulated disjoint events, each having a finite probability of occurrence, the probability of occurrence of one or more of those events will have a nonzero value approaching the sum of the probabilities of the individual events (Cardano; Arkin and Colton). This principle applies for whatever finite interval of exposure might be considered.

For example, suppose the postulated events are injuries resulting from work hazards. It then becomes apparent that a zero injury rate is achievable only if the probability component of risk for each individual hazard can truly be reduced to zero—which is unachievable in a practical work setting. If workplaces with dramatically low injury rates are examined for sufficiently brief intervals, it can appear that a zero rate has been reached when, in fact, it has not.

Based on this, one must conclude that a means to establish a practical, nonzero injury-rate goal is needed. Ideally, such a goal would be one that is rule-based and achievable, and one which resets to a more challenging value upon being realized. Adopting such a goal as a performance target would provide both a gauge of improvement and a practical motivator.

This article describes a method for setting such a goal—an injury rate performance target that can be applied on a trial basis; can be improved as experience is accumulated; and can be adopted finally as a long-term program management tool. It is a rule-based formula that helps SH&E professionals measure and promote safety improvement.
The value assigned to \( Y \) is subjectively selected by SH&E management before using the formula. This value is then altered only if protracted experience shows it to have been overly demanding or too lax. Increasing the value of \( Y \) increases the challenge of reaching the new target. A typical value would fall between 0.05 and 0.15—an increase in target achievement difficulty of five to 15 percent.

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M = \text{Improvement Discriminator, expressed as:}
\]

where:

\( R_C \) = Actual performance rate for the current rate-averaging period now ending.

\( T_C \) = Current Performance Target

\( Y \) = Target Improvement Modifier

\( T_R \) = New Performance Target

\( R_C \) = Current Actual Performance

The improvement discriminator, \( M \), satisfies these important criteria:

- \( M = 1 \) if \( R_C \) equals \( T_C \)
- \( M = 1 \) if \( R_C \) falls below \( T_C \)
- \( M = 0 \) if \( R_C \) falls above \( T_C \)

A formula of the form shown for \( T_N \), including the embedded expression for \( M \), is easily entered in a computer spreadsheet program to eliminate the burden of tedious calculations. Users of this approach may prefer to write the expression for \( M \) using logic functions rather than arithmetic functions to achieve the same result.
In applying the formula for $T_N$, an initial value must be assigned to the term $T_C$ in order to begin the calculations. This initial value may be taken as the rate for the most recent averaging period, or a long-term average rate, if preferred.

**Example Application**

Figure 1 shows the results of applying the formula for $T_N$ to injury rate data representing the performance of a workforce of 1,430 workers over a two-year period. (Size of the workforce is immaterial; both the formula and its application are independent of worker population.) The plot shown in Figure 1 covers a period immediately following adoption of a corporate plan of vigorous, top-down management accountability and involvement in SH&E program improvement. As a part of that plan, management and workforce representatives selected the value of the improvement modifier ($Y$) to be used, and both groups conducted periodic joint reviews of results.

Figure 1 shows the actual OSHA-recordable injury rate and two performance target rates. The target rates have improvement modifiers set at values of $Y = 0.05$, the value actually used, and $Y = 0.15$, included here to further demonstrate the principle. The latter is the more demanding. For both values of $Y$, an initial value for $T_C$ was set at 4.0, the actual rate most recently experienced, while an initial value for $M$ was set at 1.0. This introduced a beginning “challenge” for each of the two target rates, as shown by their reduced values for Calendar Period 2.

The actual injury rate plot in Figure 1 is typically “noisy.” Lengthening the averaging period would suppress this scatter, a statistically desirable effect. Shortening the period would amplify it and would lead to excessive adjustment of target values.

For each averaging period in which the actual rate equals or falls below either target rate, that same target rate is reduced by the improvement modifier ($Y$) for the following period. For example, this is seen in calendar periods 3, 4, 5 and 7 in the case of target $Y = 0.05$, and in periods 4, 10, 13, 16 and 19 for the $Y = 0.15$ case. For those periods in which the actual rate falls above the target (as for periods 6, 12 and 17), the target rate for the following period remains unchanged.

It should also be noted that the target rates do not increase at any point. Instead, they become progressively more demanding as safety program performance improves, but they are nonetheless achievable. They will never equal zero.

**Conclusion**

Decisions to alter this or another target-setting formula or to manipulate the subjectively selected improvement modifier ($Y$) are best withheld until statistically meaningful experience is gained working with a particular formula and its modifying parameter. Optimum selections of formulas and of their parameters will depend on several factors, not all of which are evident at the outset. Among them:

- management preferences in goal-setting between the extremes of the ineffectively lax and the unreachably demanding;
- the influence of the duration used for the data averaging period;
- the size of the workforce which, together with the duration of the data averaging period, determines the data accumulation rate.

A word of caution is in order on selecting the period of data averaging to be used. Applying the method to very brief data collection periods—or to longer periods but for a very small workforce—will result in wildly scattered “noisy” data plots and overadjustment of target values. (In such cases, results from the formula presented here can become a useful indicator that averaging periods are unrealistically short.) Brief-period averages are poor indicators of safety program performance and are to be distrusted when used with any gauging method. A period of trial use of the method will help the user avoid these problems during its later actual application. Trial periods can be simulated using past injury rate data.

Should target overadjustment be observed, SH&E management should alter the averaging period and/or the value of the target improvement modifier to correct the problem. If a brief averaging period must be used, consideration should be given to using a moving average that comprises several brief periods, both in plotting performance results and in the target formula. Plot smoothing will be the result. The smoothing improves as the number of brief periods making up the sliding average is enlarged.

The SH&E professional must be mindful that although goal-setting can serve as one among many means to prompt motivation, meaningful reductions in occupational injuries and illnesses can be realized only through steadfast persistence in identifying workplace hazards, assessing their risks in terms of severity and probability of causing harm, and bringing those risks under control. Responsibility for this must extend through all levels of the organization.

**References**


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