Practical Injury-Rate Goal-Setting

Formula helps SH&E professionals measure and promote safety improvement

By Pat L. Clemens

SETTING AN INJURY-RATE GOAL OF ZERO for a workforce has a noble, altruistic appeal. However, well-known authors in occupational safety have come to recognize that the inevitable long-term failure to achieve a zero goal is demoralizing and encourages both underreporting of injuries and falsified recordkeeping. Thus, there is need for a means to establish a realistic injury-rate target—one that is both demonstrably achievable and demanding of ongoing improvement. A performance-driven, rule-based formula can be used to set such an achievable target rate. This rate is self-adjusting, allowing it to become increasingly challenging once achieved.

Needed: Practical Injury-Rate Goal

Although a safety performance goal of zero occupational injuries and illnesses has humanitarian allure, persuasive arguments can be cited against using zero goal-setting as a practical safety program management tool:

•Experts in performance evaluation discredit the practice. For example, when discussing risks that lead to injuries, Manuele writes:

> It is not possible to attain a risk-free environment, even in the most desirable situations. Setting a goal to achieve zero . . . may seem laudable, but it requires chasing a myth (Manuele).

Deming's tenth point for management states, "Eliminate slogans, exhortations and targets for the workforce asking for zero defects . . ." (Deming). Although addressing the flawed doctrine of zero defects in particular, Deming applied the principle universally.

Tarrants similarly observed:

> . . . a zero accident incidence, although ideally desirable, is not the universal standard for safety effectiveness. . . . Achieving a zero accident frequency rate is a meaningless goal (Tarrants).

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•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, regularized targeting method that can be used either in conjunction with, or as a substitute for, other safety program goals.

Criteria & Formula for a Target Rate

The occupational safety literature offers little to guide an SH&E practitioner in setting practical injury-rate goals. Goal-setting is a topic dealt with in behavioral psychology, however. Researchers in that field often use, as examples, performance goal-setting for sports such as track and field.

The results of this work can be easily applied to other endeavors. For example, Locke and Latham present these criteria for setting and achieving goals:

•Avoid setting nonspecific goals (e.g., "Do better!") in favor of specific goals that are quantitatively expressed (e.g., "Lose three pounds over the next two weeks").

•Maintain performance records showing progress—or lack thereof—toward achieving a goal.

•To reach long-term goals, use a succession of short-term goals that can be realistically achieved in the time span allotted (Locke and Latham).

For occupational injury and illness rates, goal-setting would be expected to satisfy these same criteria. In addition, a practical injury rate performance goal would do well to be:

•cognizant of recent actual performance to avoid an impractical expectation of improvement;

•demanding yet capable of realization (i.e., realistically achievable);

•self-adjusting when achieved to perpetuate motivation and foster ongoing improvement;

•rule-based to minimize arbitrariness.

Many target-setting formulas that satisfy these criteria can be constructed. A conveniently written formula with these attributes has this form:

$$T_N = T_C\,(1-YM)$$

where:

T_N = Performance Target value, adjusted for the next rate-averaging period ("new" target rate).

T_C = Performance Target value for the current rate-averaging period now ending ("old" target rate).

Y = Target Improvement Modifier (i.e., the proportion by which the target value is reduced following a rate-averaging period in which the actual rate equals or falls below the target value that had been set for the period).

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.

M = Improvement Discriminator, expressed as:

$$M = 1 + \left(\frac{(T_C - R_C)}{|T_C - R_C| + 10^{-4}}\right) \times \frac{1}{2}$$

where:

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

Note that the expression (T_C - R_C) appears both in the numerator and denominator of one term making up the expression for M. In the denominator, it is the absolute value of this term that is used; in the numerator, the real value is used. As a result, the two terms do not alter the numerical value of M. Instead, they produce a sign indicating whether the actual rate has achieved the target value set for the current period. The sign is positive if the rate has equaled or fallen below the target value and negative if it has remained above it. The miniscule constant 10^{-4} appearing in the denominator precludes indeterminate evaluations for cases in which $R_C = T_C$.

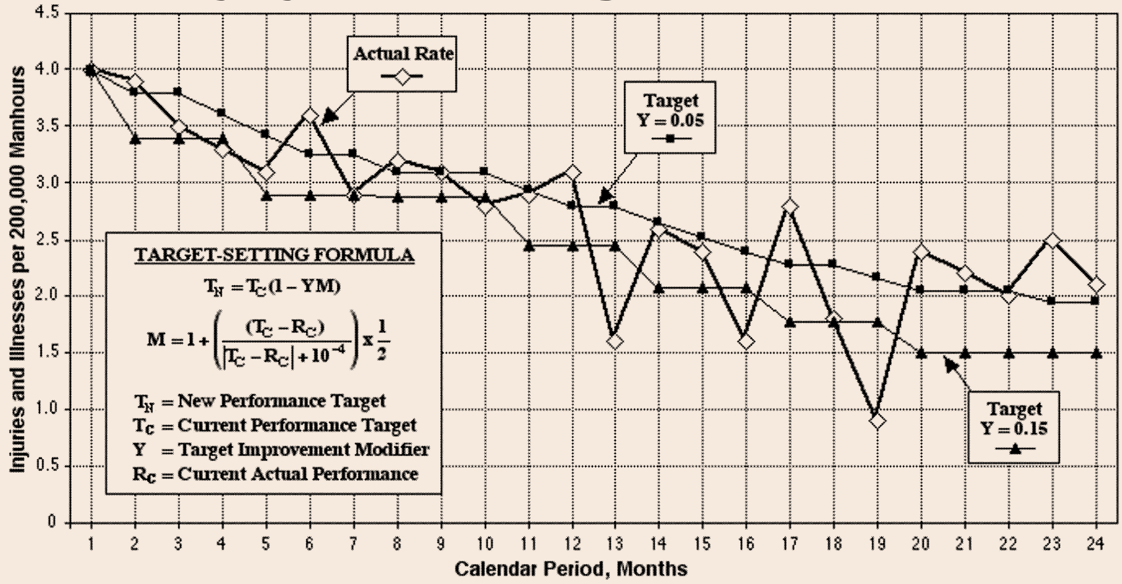
The improvement discriminator, M, satisfies these important criteria:

•If R_C equals T_C . . . . M = 1
•If R_C falls below T_C . . . . M = 1
•If R_C falls above T_C . . . . M = 0

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.

Figure 1

Actual Injury Rates & Target Values



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. ■

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