Using Work-Sample Physical Ability Tests to Maintain Fitness Standards of Incumbent Firefighters

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In 2000, the National Fire Protection Agency made a bold but profound statement: "Overweight, out-of-shape fire fighters are an accident waiting to happen" (NFPA, 2000). While the statement can be supported by common sense alone, research data shows just how true this statement really is. For example, a 2005 study revealed that nearly 50% of all injuries to civilian firefighters in that year were a result of sprains, strains, and muscular pain—whereby overexertion is considered the primary causative factor (NIST, 2005). Additionally, over 59% of all on-duty firefighter fatalities in the United States in 2011 were caused by stress and/or overexertion which resulted in a heart attack (FEMA, 2011).

Firefighters are charged with the serious responsibility of ensuring the safety of their crew and the public. Fire departments are motivated to reduce worker compensation claims, thereby reducing employment costs, which only constitutes some of the costs related to firefighter injuries. After tallying all of the costs related to firefighter injuries in 2002, NIST estimates the annual price to fall between $2.8 and $7.8 billion (NIST, 2005).

This background shows why many fire department executives are passionate about ensuring the high fitness levels of their active fire suppression personnel. While this may be the case, a national research survey of 185 chief-level fire officers[1] revealed that only 25% of fire departments use physical ability tests (PATs) as *annual maintenance standards* for ensuring the fitness levels of their incumbent fire suppression personnel. This survey revealed that a much higher percentage (88%) use PATs for pre-screening firefighters. So, while fire departments seem intent on screening fit candidates *into* their departments, maintenance testing programs are not typically put into place to continually ensure the fitness level of incumbent fire personnel.

[1] The study was conducted by the authors in 2011. The survey sample included 151 Fire Chiefs, 12 Assistant Fire Chiefs, 8 Battalion Chiefs, 6 Deputy Chiefs, 4 Deputy Fire Chiefs, 4 Division Chiefs (185 total). The average department size was 123, with an average of 109 active fire suppression personnel. The smallest department included had 9 full-time employees; the largest had 1,790.

This is not because fire departments do not believe in the importance of ongoing testing. Indeed, this same survey revealed that 93% of the fire chiefs believed that, "Active Fire Suppression Personnel should be tested annually to ensure that they possess the minimum physical abilities necessary to successfully perform the job." This shows overwhelming support for using PATs as a maintenance standard. So, why is there such a gap between this 93% endorsement and the fact that only 25% of fire departments actually use PATs for maintenance standards? Is it the union? Fear of employment lawsuits from personnel who cannot pass the PAT test standard? The answers likely differ from department to department.

Regardless of the reasons behind why the majority (75%) of fire departments do not use a maintenance standard, the reasons for installing a PAT as a maintenance standard are worth serious consideration. In addition to the injuries, the costs from injuries, and the importance of protecting and preserving life and property, there is the fact that firefighters simply *age* after they start the job, and aging has a direct impact on fitness levels. For example, one study[2] involving 256 incumbent fire suppression personnel (with an average age of 34.83 years) revealed a very high correlation ($r = .397$) between age and test scores (in seconds) on a work sample PAT. This correlation translates to roughly *five seconds slower per year*.

To put this into perspective, a 25 year-old firefighter has a predicted score on the work sample PAT of about eight minutes, whereas a 50 year-old firefighter has a predicted score of ten minutes. This two-minute score difference is attributable to age alone. This trend clearly indicates that age, if left to its natural process without fitness training interventions, will gradually move a minimally-qualified firefighter who (at age 25) barely passed the job-related minimum cutoff score (9 minutes and 34 seconds on this particular PAT), to a score that is one full minute slower in just 12 years.

This phenomenon presents fire departments with three options: (1) do nothing and cope with a workforce with naturally declining physical abilities, (2) install a wellness program and hope that job-related standards associated with important fire suppression tasks are positively impacted, or (3) install a wellness program *coupled with an annual maintenance standard using a work sample PAT*. The latter option actually ensures that active fire suppression personnel will maintain job performance standards.

Departments that adopt work sample PATs as an annual maintenance standard must address three controversial issues: (1) selecting an appropriate cutoff time for the test (the same time used for entry level or slower/faster), (2) choosing which positions will be selected for the annual testing requirement, and (3) identifying the steps that will

[2] Study conducted by FPSI (2011) involving firefighter incumbents from over 40 fire departments on a single PAT.

be taken with incumbents who cannot pass the annual test, even after repeated retest opportunities. These issues are addressed next.

Selecting a Cutoff Time for an Applicant or Incumbent Work Sample PAT

Taking the proper steps to develop validated cutoff scores for continuously-timed "work sample style" PATs, for both *applicant* (pre-hire) and *incumbent* (post-hire) populations, will help insure both fairness and defensibility in court. Part of this process should specifically address the criteria in the Uniform Guidelines regarding the *normal expectations of acceptable proficiency in the workforce* (Section 5H) and other relevant criteria from federal and professional testing standards.

When it comes to setting cutoff scores that represent the *normal expectations of acceptable proficiency in the workforce*, it might seem natural to simply run a sample of incumbents through the PAT and set the cutoff score at the *average* time that it took incumbents to complete the test. There are several problems with this approach, the first being that such an approach would assume that about one-half of the workforce (i.e., those that scored below the average) are inadequate performers.[1] In addition, there are four additional challenges:

1. Possible skill advantage of the incumbent workforce.
2. Influential outliers.
3. Sampling error.
4. Test unreliability.

Each of these will be discussed below.

Possible Skill Advantage of the Incumbent Workforce

The goal of a PAT used for screening entry-level applicants is to measure their ability to perform the requirements of the job at a level required *on the first day of employment* (i.e., before training or on-the-job experience) (see Section 14C1 of the Guidelines). Measuring the performance levels of the current workforce can provide useful information on setting cutoff scores for untrained applicants, but not without some complications that first need to be addressed:

1. The incumbent workforce with less than one year of experience can sometimes have higher ability levels on the work sample tasks included on the test. This is due to their recent completion of the training academy (where some of the training is targeted at improving their underlying ability and fitness levels, as well as their job-specific skills). In many circumstances, this advantage is short-lived and is not continued through job tenure (unless it is sustained through on-going physical training).

2. The incumbent workforce may possess skill levels that are higher than entry-level applicants, *even if the applicants possess identical levels of the underlying abilities measured by the PAT*. This may result from post-academy time on the job to practice the work behaviors that may be represented on the PAT. Although (valid) work-sample style PATs should exclude test content that is “learned in a brief orientation” or “trained on the job” (these are two typical ratings in PAT content validation studies designed to address Section 14C1 of the Guidelines), it may not be possible to remove *all* skills and techniques that may give incumbents an advantage when completing the PAT. Even if the test is completely free of such content, there is still a possibility that incumbents, through their regular practice and application of the work behaviors that are similar to those represented on the test, may have an advantage. This “incumbent advantage” may be 1%, 5%, 10%, or higher, but is likely present in most PATs.

Influential Outliers

Most groups of incumbents selected to complete a PAT (especially when the purpose is to set a cutoff that will be used for setting a maintenance or “return-to-duty” standard that will be applied to the same group) will typically include one or more “exceptionally high” and “exceptionally low” incumbent scores. These “outlier” scores have more influence on the mean and the variability of the sample because of how the underlying math works for computing both of these statistics. These outliers are sometimes referred to by statisticians as “influential data points” because they are outside of the normal range of the score distribution. For this reason, these outliers be identified and removed from the data set using the process described below.

Sampling Error

The average score that is derived from running the incumbent workforce through the PAT is subject to *sampling error*. Unless the *entire workforce* runs through the PAT, the average obtained from running the sample of incumbents through the test will be subject to natural variability that occurs around the central parts of the distribution. This sampling error (called the *Standard Error of the Mean*, or *SE Mean*) is 0 when the entire workforce runs through the PAT, and increases in value when the sample selected is small (in an absolute sense) and the sample selected is small relative to the population from which it was chosen.

By definition, the *SE Mean* is the confidence interval that surrounds the average derived from the sample. For example, an average incumbent time of 300 seconds obtained from a sample of 30 incumbents (who were selected from a population of 200) with a Standard Deviation (SD) of 30 seconds will have a SE Mean of 5.06 seconds (using the computations discussed below). This means that 68% of the additional samples of 30 incumbents that are drawn from this population of 200 incumbents will likely produce average scores between 295 seconds and 305 seconds (5 seconds above/below the 300-second average obtained from the first draw of 30 incumbents). This variability produces uncertainty about the average obtained from the first sample draw, but can be accounted for by simply adding 1 *SE Mean* to the average.

Test Unreliability

Every assessment device used in personnel testing produces scores that are less-than-perfect estimates of the examinee's true ability level measured by the test. Applicants who take a PAT are not exempt from this phenomenon, as they will achieve a different score almost every time they take the PAT. The best way to estimate this variability on a continuously-timed work sample PAT and develop a fixed confidence interval around such hypothetical "repeat test scores" is to administer the test twice to a group of incumbents (e.g., n > 50) and compute an ICC[2] (a type of reliability estimate for test-retest conditions) which can be combined with the Standard Deviation of scores to produce a Standard Error of Measurement (*SEM*) using the formula:

$$\text{SEM} = \sigma_x \sqrt{1 - ICC}$$

Where σ_x is the Standard Deviation of test scores (from the first administration, where examinees are less "practiced") and *ICC* is test-retest reliability coefficient of the test. For example, a test with an *ICC* value of .70 and a Standard Deviation of 50 would result in an *SEM* of 27.39 ($50\sqrt{1-.70}$).

Much like the Standard Deviation of test scores, the *SEM* can be used to estimate *boundaries* around test scores. However, in the case of the *SEM*, the boundaries pertain to an individual examinee's *true score,* given their *observed score*. Observed scores are simply that—the score that a researcher observes a certain examinee achieves. True scores, however, represent the score that most accurately represents the examinee's true, actual ability level (as represented by the test). The true score can also be regarded as the average score an examinee would achieve if they (hypothetically) completed the test 1,000 times.

For example, an examinee who scores 500 seconds on a first administration of the test (i.e., the observed score) likely has a true score between 473 seconds and 527 seconds (1 *SEM* seconds below and above the observed score). This 1-*SEM* boundary around the examinee's observed score encapsulates their true score with 68% certainty. Using 2 SEMs to establish this boundary sets the true score boundary with 95% certainty.

Because each examinee's true score has a 50% likelihood of existing at or below their observed score, and a 50% likelihood of existing at or above their observed score, a researcher can determine the probability of an examinee's true score existing at a certain score *or higher*. This means that this examinee's true score is 84% likely to exist *at or below* a score of 527 seconds (the 500 second observed score plus 1 *SEM* (27) = 527 seconds). The 84% is determined by adding 34% (half of the 68% bi-directional boundary obtained using 1 *SEM*) to the 50% likelihood that their true score is lower than their observed score. Thus, the odds are about 6-to-1 (1 ÷ 16%) that this examinee's true score is at or below 527 seconds.

The *SEM* can be multiplied by the square root of two (2) to compute a *Standard Error of Difference* (*SED*), which is a metric that is useful for establishing a confidence interval *between* two scores. So, the *SED* is concerned with differentiating *between* the true scores of examinees given their observed scores, whereas the *SEM* identifies the range surrounding one examinee's true score given their observed score. Using the example above, the *SED* can be computed as: $SEM * \sqrt{2}$ or 27.39 * 1.41421 = 38.73.

After computing the *SED*, the *SED* can be multiplied by a confidence interval (e.g., 90%) to establish a specified degree of confidence regarding the distance (i.e., number of scores) above or below before reaching a score that represents a *meaningfully different ability level*. In other words, the *SED* can be used to identify two *true scores* that are reliably isolated in the score distributions so that the hypothetical "repeat test scores" of two examinees would not likely overlap. For example, multiplying the *SED* by 1.645 and adding this product to the average score sets the 95% limit for scores that are reliably within the "normal" upper range as marked by the average score. Using our example above, we arrive at this "outside boundary score" as: 500 second (average) + *SED* (38.73) * 95% Confidence Interval (1.645) = 63.71 = 564 seconds (rounded up). Thus, applicants who score 564 seconds or faster are within the "normal range" (or faster), and applicants who score slower than 564 seconds are outside of this "normal" range, and exist within an ability range that is *meaningfully outside* of the "normal."

Putting the Factors Together and Setting Cutoff Scores for Applicants and Incumbents

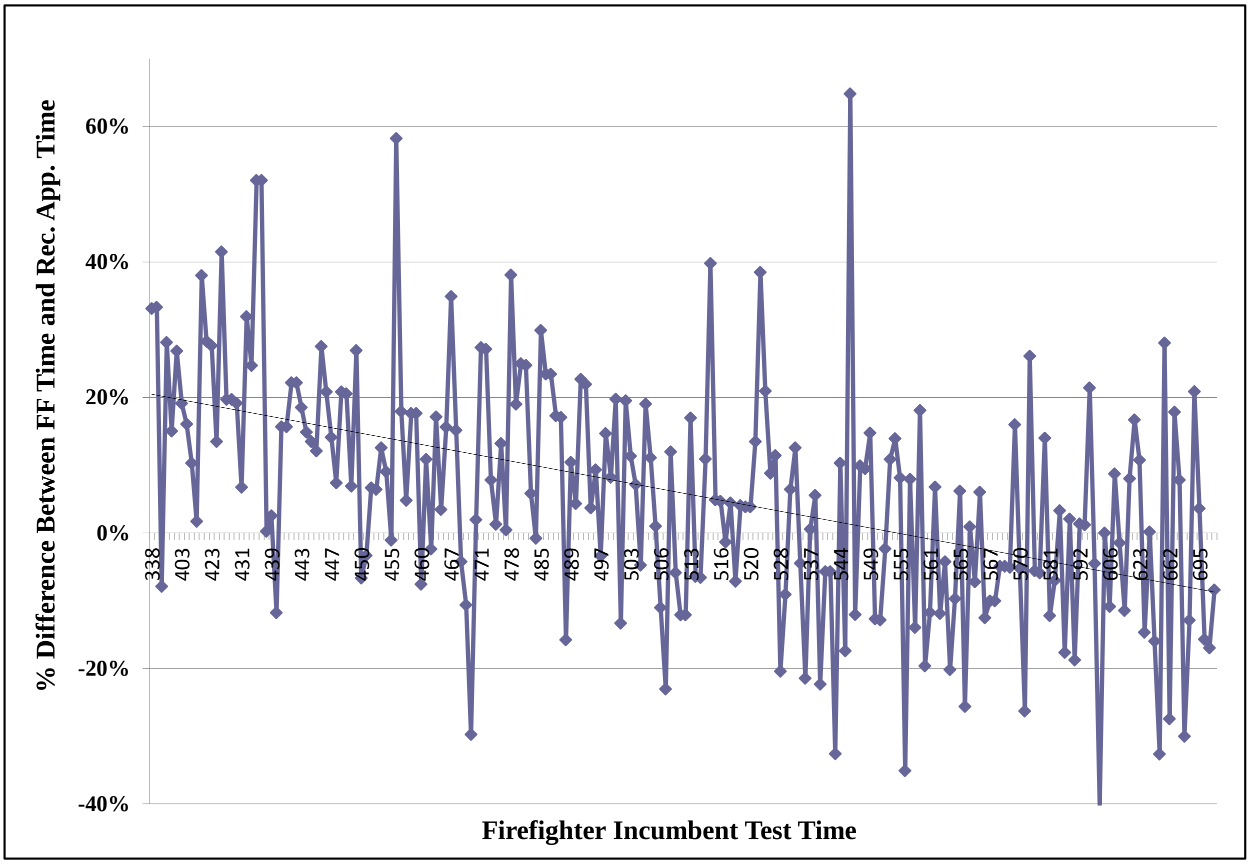
The discussion above demonstrates that setting cutoff scores that represent the "normal expectations of acceptable proficiency of the workforce" is not as easy as testing the incumbent workforce and using the average. Further, even using a simple descriptive statistic (such as adding one standard deviation to the average), would not address the four factors discussed above (the possible skill advantage of the incumbent workforce, possible influential outliers, sampling error, and the unreliability that is inherent with the test).

The process described below shows how each of these factors can be integrated into a process for setting applicant and incumbent cutoff scores for a firefighter PAT. This discussion assumes that a content validated, continuously-timed work sample PAT is being used. At a minimum, such a test should include events that are (as much as possible) net of techniques that are trained on the job (by either removing such techniques, teaching them to the applicants beforehand, or setting up the events so that the techniques are built into the testing process), and includes only events where speed (rapid, yet safe, movement) is important both within and between the events.

Step 1: Adjusting for the Possible Gap between the Incumbent Workforce and the Applicant Population. One way of completing this step is to run active fire suppression incumbents (typically captain and lower ranks) through the test, then having them complete a brief survey that asks their opinion regarding the time in which a *minimally-qualified applicant* (i.e., with no academy or job training) should be able to complete the test (see the Angoff method described in Biddle, 2010).

After tabulating the incumbent actual times and opinion times, two results are very likely. First, their average actual times and opinion time will be different, with slightly more time being afforded to the applicants. Second, a negative correlation will emerge between these two values and the time in which the incumbents completed the test. In other words, the fastest incumbents will likely extend more time (than their own time) to applicants, and the slowest incumbents will likely extend less time to the applicants. This phenomenon has occurred in every one (of numerous) datasets the authors have evaluated, and likely occurs because the exceptionally fit incumbents recognize that typical applicants may have less ability, and less fit incumbents may desire stronger ability levels of incoming applicants. Figure 1 demonstrates this graphically using data from a study that involved 214 firefighters from 41 departments in a consortium study.

Figure 1. Difference between Firefighter Actual Time and Recommended Applicant Time



Given the fact that this strong negative correlation exists between actual and recommended times (r = -0.462 in this study, and even stronger in other studies[3]), regression can be used to identify adjustments that can be made at various score levels to account for the skill advantage that incumbents may possess. For example, Figure 1 shows that the predicted recommended applicant time is about 12% slower (506 seconds) for “fast” incumbents who score 443 seconds (1 SD below the mean), about 5% slower (541 seconds) for incumbents who score at the mean (516 seconds), and 2% faster (576 seconds) for “slower” incumbents who score 589 seconds (1 SD above the mean).

This data is useful because it can be used in a regression formula to predict the additional amount of time that should be given to applicants at various score levels in the incumbent population. For example, in one study[4] conducted by the authors the “applicant advantage” score was computed to be 5.56% at the average score. Because this value represents the predicted opinion at the normal (i.e., average) point of the score distribution, it can be simply added to the incumbent average score to arrive at a starting place for computing the cutoff score for applicants (see additional steps required below).

Step 2: Remove the Outliers

This step is important because nearly every incumbent score distribution will have outliers, and these outliers can have a significant influence on cutoff scores due to their "extra" influence on the average score used in the process of cutoff-score setting. There are a number of different methods available for "trimming" outliers, ranging from manual to automatic methods. While most methods will return similar results, one decision must be made surrounding the percentage of data points to trim, with the minimum being a "5% trim" (where the lowest and highest 5% are removed, or 10% total) to a "20% trim." (Wilcox & Keselman, 2003)

Trimming the data can be done in several ways. The method we recommend for PAT scores is to remove the outliers from both the mean and SD because, if they are truly viewed as "outliers" (i.e., not representative of the "normal score ranges" that will be used for determining the cutoff score), they should be completely removed from the cutoff determination process. However, while trimming the outer regions of a distribution can lead to more accurate estimations of the true population mean, doing so can also suppress the variability (the SD) because the extreme data points contribute the most variance to such formulae.

For this reason, and because the SD is being used in this process to set boundaries regarding the normal expectations of acceptable proficiency, we suggest trimming the SD using 1.645 SD trimming rule, which only excludes 10% of the data (5% on each side). This is done by computing the mean and SD of the entire distribution, multiplying the SD by 1.645, and excluding the values that exceed this range (on both the high and low side). For example, given a mean of 500 seconds and a SD of 100 seconds, all scores below 335 seconds (500-(1.645*100) and above 665 (500+(1.645*100) would be removed from the dataset.

While a variety of procedures and methods may be useful for trimming outliers, the authors have found the process described above especially effective because the vast majority of incumbent datasets from incumbents have been significantly skewed (with a disproportionally high number of slower incumbents than faster incumbents in the dataset).[5]

Step 3: Correct for Sampling Error

The SE Mean can be computed using the following formula:

$$SD / \sqrt{N}$$

where SD is the SD of the untrimmed scores and N is the sample size. This value should be reduced by multiplying it by the Finite Population Correction (FPC)[6] value, computed by:

$$\sqrt{\frac{N-n}{N-1}}$$

where N is the total fire suppression population and n is the sample included in the study.

Step 4: Account for Test Reliability

Use the process described above to compute the test-retest reliability (as an ICC statistic), then the SEM, and finally the SED. Then multiply the SED by a Confidence Interval of 1.96 to identify the score that represents a 95% confidence level (one-tail) surrounding the outside boundary of the average score.

If possible, the test-retest reliability (ICC) for the entry-level PAT should be computed using untrained applicants or new recruits, and the ICC for the incumbent PAT should be computed using fire suppression personnel. This is because their reliability is likely to be lower than trained and experienced incumbents due to their having less on-the-job experience with the same or similar activities. For our example, the authors conducted a test-retest study with 59 new fire recruits that resulted in ICC = 0.6979 (for a work-sample PAT that had an average time of about nine minutes) and a test-retest study for incumbents for a similar PAT that resulted with a higher ICC (ICC = 0.7927). Use the ICC from the untrained applicants in the cutoff process described below for the entry-level PAT (see below), and the ICC from the fire suppression personnel for the incumbent PAT.

Step 5: Combine the Computation Values to Set Cutoff Scores for Entry-Level Applicants and Incumbents (as a Maintenance Standard)

Given the discussion of the factors and computations above, the following formulas can be used for computing passing scores (cutoffs) for entry-level applicants and incumbents (as a maintenance or return-to-duty standard) as shown below.

Formula for Setting Cutoff Scores for Entry-Level Applicants:

Trimmed Mean + (Trimmed Mean * 5.56%) + (SE Mean * FPC) + (SED * 1.96)

Process for Setting Cutoff Scores for Incumbents (for a Maintenance or Return-to-Duty Standard):

Trimmed Mean + (SE Mean * FPC) + (SED * 1.96)

The final cutoff for either process above should be set by rounding the calculated value up to a whole second (e.g., 500.1 seconds should be rounded up to 501 seconds) because it is easier to monitor pass/fail determinations in whole seconds.

While the results of the process above will vary, the cutoffs will typically be set so that >90% of the incumbents would pass the applicant standard and 80% to 90% of the incumbents would pass the maintenance/return-to-duty standard.

Finally, one additional point should be discussed regarding these cutoff-score-setting processes and related concepts. This has to do with the *use* of test scores. While these concepts and steps are useful for setting minimum standards, a criterion-related validity study may generate evidence that scores above minimum levels differentiate job performance. In such circumstances, using a cutoff score (or banding) may be justified, however, the level of adverse impact should also be considered.

Should Age and Gender be Considered When Setting the Cutoff for an Incumbent Maintenance Standard?

There is a growing concern that the age and gender of the incumbent will affect performance on the PAT and that adjustments should be made to address these factors. However, Section 106 of the Civil Rights Act (CRA) of 1991 prohibits the use of gender-based standards stating:

> It shall be unlawful employment practice for a respondent, in the connection with the selection or referral of applicants or candidates for employment or promotion, to adjust the scores of, use different cutoff scores for, or otherwise alter the results of, employment related tests on the basis of race, color, religion, sex or national origin.

Additionally, the American's with Disabilities Act (ADA) of 1990 states that employee standards must be job related. Specifically, Section 103 of the ADA states:

> (a) In general. It may be a defense to a charge of discrimination under this chapter that an alleged application of qualification standards, tests, or selection criteria that screen out or tend to screen out or otherwise deny a job or benefit to an individual with a disability has been shown to be *job-related and consistent with business necessity*, and such performance cannot be accomplished by reasonable accommodation, as required under this subchapter.
>
> (b) Qualification standards. The term "qualification standards" may include a requirement that an individual *shall not pose a direct threat* to the health or safety of other individuals in the workplace.

Given the nature of the firefighter job and the consequence of error associated with an applicant or incumbent who is unable to perform the critical duties, adjusting a PAT cutoff score based on age or gender, for either applicants or incumbents, not only violates the CRA of 1991 and the ADA of 1990, but could very likely put the health and safety of fire suppression personnel in danger.

Which Positions Should be Included in an Annual Maintenance Testing Program?

When fire chiefs who participated in the research study were asked the controversial question regarding which ranks should be required to pass an annual maintenance PAT, the results showed a clear cluster that included four ranks: Firefighter, Fire Engineer, Fire Lieutenant, and Fire Captain. Over 70% of the survey respondents were in clear agreement that maintenance PATs would be appropriately required for these positions. The next cluster included the Training Officer and Battalion Chief positions, which were both tied at about 60% agreement. The higher-level ranks (which included Fire Marshall, Division Chief, Assistant Chief, and Chief) fell between 30% and 40%, indicating that being able to pass an annual maintenance PAT was clearly less important for these ranks. Figure 1 shows these results graphically.

Figure 1. Fire Personnel Required to Pass Annual Maintenance PATs

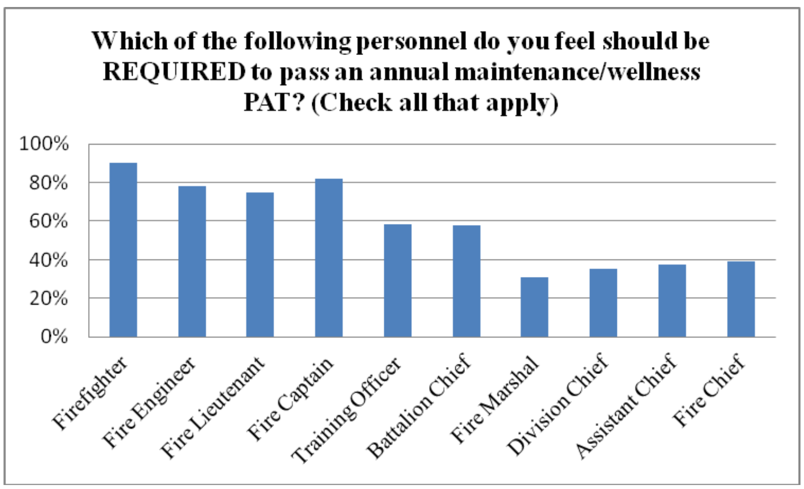
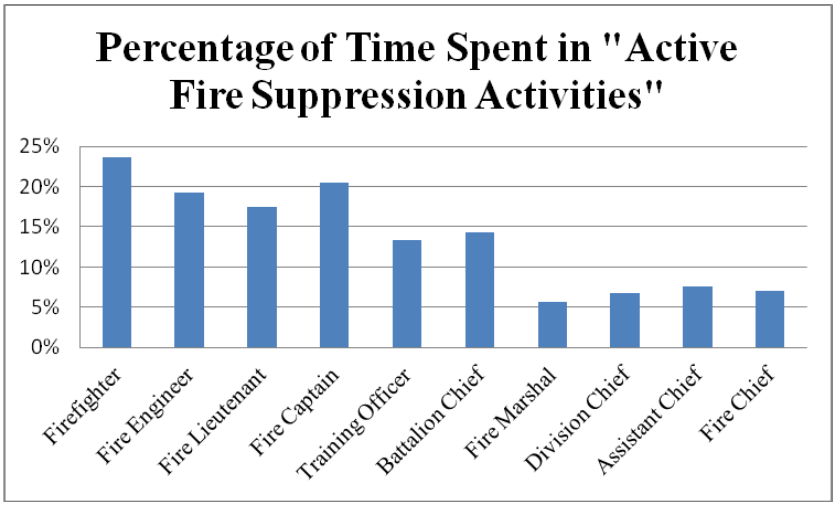


Figure 2 below shows the percentage of time that various ranks spend in active fire suppression activities. These results reveal the reasons behind the results provided in Figure 1—*i.e.*, the importance of using a maintenance PAT is directly tied to the percentage of time that various ranks spend in fire suppression activities.

Figure 2. Percentage of Time Spent in Active Fire Suppression Activities (by rank)



The study revealed that the average percentage of calls that were fire suppression calls was 21%, with a standard deviation of 13.5%. The percentage of calls that were EMS was 71%, with a standard deviation of 14.8%. There was no correlation between department size and type of calls, which reveals that the ratio of fire to EMS calls is not dependent on department size.

Choosing which positions to include in an annual maintenance testing program should clearly be a department-by-department decision. With that said, the data reveal that the four positions that are traditionally "hands on" when it comes to fire scene management should certainly be included in most situations. This includes the ranks of Firefighter, Fire Engineer, Fire Lieutenant, and Fire Captain. In most departments, the Training Officer is not directly involved in responding to fire emergencies. The Battalion Chief position, however, is different because field deployment levels of this position is sometimes high, and will vary by assignment (e.g., training, administrative, etc.) as well as department size. The higher-level ranks (*e.g.*, Fire Marshall, Division Chief, Assistant Chief, and Chief) will typically be exempt from maintenance programs.

What Steps Should Departments Take with Incumbents who Fail Annual Maintenance Standards?

The research conducted surrounding this issue included a question that asked respondents: "Which of the following consequences do you feel are acceptable for ACTIVE FIRE SUPPRESSION who cannot pass a maintenance/wellness PAT?" The four response options that were provided to respondents were:

- Conditioning program—The incumbent is placed on a program that includes dietary modification and physical training.
- Leave of absence—The department may elect to place the incumbent on a leave of absence until which time the incumbent is able to pass the test.

- Disability leave—The department may elect to place the incumbent on disability leave until which time the incumbent is able to pass the test.
- Retirement with pension—The department may elect to terminate employment with the incumbent following continued attempts to improve test performance without success.

  The results from this survey question are provided in Figure 3.

Figure 3. Consequences for Failing Maintenance PATs

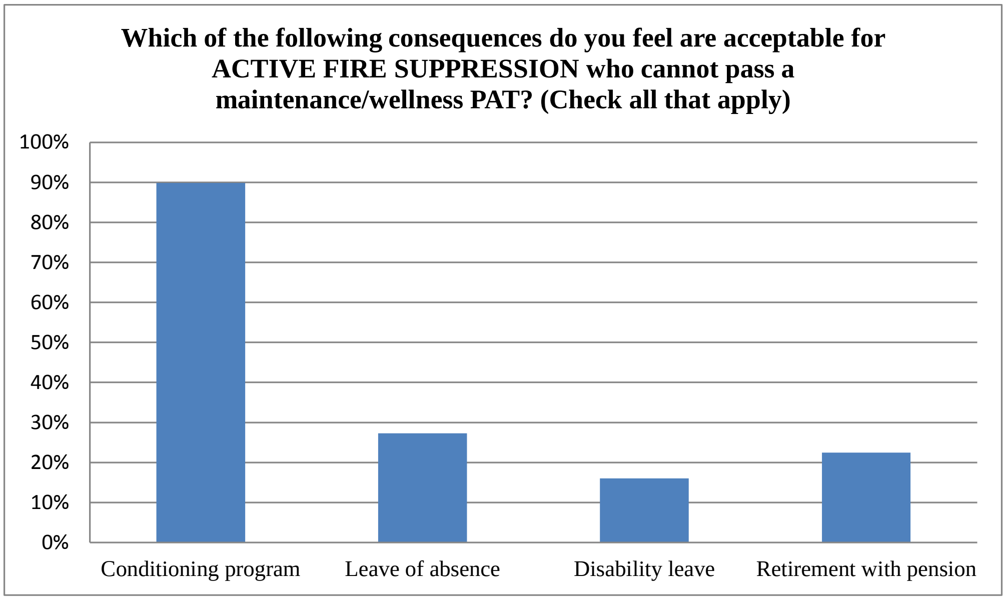


Figure 3 shows that most responding chiefs (90%) agreed that requiring a condition program was a sound “natural consequence” for incumbents who cannot pass a maintenance PAT. However, a significant portion of the chiefs stated that more severe consequences (taking a leave of absence or retirement with pension) would also be justified (with 27% and 22% endorsement, respectively). Only 15% endorsed the most extreme consequence (required disability leave).

Before moving to one of these three severe consequences, we suggest first allowing the candidate (up to) two retesting opportunities (each separated by a 10-16 week training program). The 10-16 week training program should consist of both cardiovascular and strength training in the specific, fire suppression-related work behaviors that are measured by the test. Departments can choose whether they want the training program to be self-directed or conducted by a department-designated exercise specialist.

What Steps Should Departments Take with Incumbents who Pass Annual Maintenance Standards?

A number of fire service officers have shared their opinions on whether or not an incentive is appropriate for those incumbents who successfully complete and pass an annual maintenance standard. Opinions vary from offering a 3% increase in pay, to providing 48 hours of comp time, to nothing. The rationale for implementing an incentive, to motivate the incumbents to stay fit and competent to perform the physical demands of the job is that the amount of money saved in worker’s compensation claims well outweighs any burden of additional expense to the departments’ budget.

Conclusion

The incumbents surveyed in the 2011 national research study were asked which fire suppression personnel should be required to pass an annual PAT. Some of the more common responses ranged from: "*Everyone issued turnout gear should pass a physical every year*," (Anonymous, 2012) to "…*there needs to be a mandatory annual physical assessment for anyone that performs suppression duties - be that an A/C or a Training Chief or even the Chief if he does that - plus that would be a great way to show everyone that the playing field is level…No one wants to put good people out of a job, but how long do you let the good guys slide - and create a hazard for themselves and the rest of the department?*" (Anonymous, 2012).

While there may be differing opinions on exactly *who* should be required to pass an annual maintenance PAT and *what* the consequences should be for those who cannot pass the test, one thing is certain, fire departments should implement a maintenance test into their incumbent workforce for the safety of both the public and the department.

In 2012, the United States Fire Administration published firefighter health and wellness Resolutions for the New Year and encouraged fire departments to: "provide physical exams to each firefighter and responder in the department in accordance with the National Fire Protection Association (NFPA) 1582 – Standard on Comprehensive Occupational Medical Program for Fire Departments" (USFA, 2012). Additionally, USFA encourages fire departments to implement a comprehensive fitness program per NFPA 1583 – Standard on Health-Related Fitness Programs for Fire Department Members.

Many chief officers may prefer to implement a wellness program over instituting a maintenance standard on their incumbent workforce. There is little doubt that a wellness program could be helpful in identifying specific health concerns that may require intervention (e.g., cholesterol, diabetes, skin cancer, etc.). However, these wellness programs will not identify those incumbents who are physically unable to perform a variety of simulated fire suppression activities as easily as an annual maintenance test can. For example, it is possible for an incumbent to participate in a wellness program that identifies the incumbent as a "fit" firefighter (e.g., a healthy body-mass index, a healthy resting pulse rate, good blood pressure, etc.), but this "fit" firefighter may not be able to successively drag a charged 1 ¾" hoseline for 70 feet, drag a 175-pound dummy for 20 feet, and then climb four flights of stairs while carrying a 40-pound hose bundle. The clear distinction between the wellness program and the maintenance test is this: The wellness program will identify incumbents who *should* be able to successfully perform fire suppression duties, but the maintenance test will identify incumbents who *can* successfully perform fire suppression duties.

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[1] It should be noted that some situations may include job incumbents who are performing inadequately as an overall group. In this circumstances, deviations from the steps described herein may be made.

[2] This can be computed in SPSS by inserting Time 1 scores and Time 2 scores in their respective columns and analyzing the scale reliability using Intraclass Correlation Coefficient, Two-Way Mixed (with "Absolute" type), and using the "Average Measures" value from the resulting output. See, for example: Weir, J.P. (2005). Quantifying test-retest reliability using the intraclass correlation coefficient and the SEM. *Journal of Strength Conditioning Research, 19* (1), 231-240; Wang, C.Y. & Chen, L.Y. (2010). Grip strength in older adults: Test-retest reliability and cutoff for subjective weakness of using the hands in heavy tasks. *Archives of Physical Medicine for Rehabilitation, 91*, pp. 1747-1751; Gross D.P. & Battie, M.C. (April, 2002). Reliability of Safe Maximum Lifting Determinations of a Functional Capacity Evaluation. *Physical Therapy, Vol 82*, No 4; Isernhagen S.J., Hart D.L. & Matheson L.M. (1990). Reliability of Independent Observer Judgments of Level of Lift Effort in a Kinesiophysical Functional Capacity Evaluation. *Work 12*, 145-150; Reneman, M.F. & Brouwer, S., Meinema, A. Dijkstra, P.U., Geertzen, J.H.B., Groothoff, J.W. (December 2004). Test-Retest Reliability of the Isernhagen Work Systems Functional Capacity Evaluation in Healthy Adults. *Journal of Occupational Rehabilitation, 14,* No 4, pp. 295-305; Reneman, M.F., Dijkstra, P.U. Westmaas, M., Göeken, L.N.H. (December 2002). Test-Retest Reliability of Lifting and Carrying in a 2-day Functional Capacity Evaluation. *Journal of Occupational Rehabilitation, 12,* No 4, pp. 269-275; Wang, C.Y. & Chen, L.Y. (2010). Grip strength in

older adults: Test-retest reliability and cutoff for subjective weakness of using the hands in heavy tasks. *Archives of Physical Medicine for Rehabilitation, 91*, pp. 1747-1751.

[3] This trend is typical is most studies conducted. For example, three other studies revealed negative correlations of *r* = - .65, *r* = - 60, and *r* = - .77 for department sizes of n = 61, n = 60, and n = 37, respectively. The authors acknowledge that some degree of this correlation is due to the auto-correlation that occurs with less time being available to correct with faster times, and more time with slower times (e.g., a 30-second adjustment on a 300-second score is 10%, whereas the same 30-second adjustment on a 600-second score is only 5%). However, each of the distributions studied revealed negative corrections almost always being made in the slower score ranges (where less time than the firefighter's time is recommended for the applicant).

[4] This study involved four independent studies representing 44 total departments and 372 firefighters. The 5.56% was computed using a sample-size weighted applicant advantage across all four studies.

[5] For example, studies conducted by the authors revealed the PAT incumbent score data from 4 out of 5 fire departments (representing a combined sample size of 430 incumbents) to be significantly skewed, with skewness test results of 4.12, 3.24, 4.47, 1.86, and 2.77 (skewness test values are computed by dividing the skew value by the standard error of the skew, with values exceeding 2.0 indicate "significant" skew).

[6] Isserlis, L. (1918). On the value of a mean as calculated from a sample. *Journal of the Royal Statistical Society* (Blackwell Publishing) 81 (1): 75–81. (Equation 1)