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FRONT LINE MOBILE HEALTH

One job, one standard

HOW AEROBIC CAPACITY STANDARDS IN NFPA 1580 AFFECT OPERATIONAL STAFFING AND WHAT YOU CAN DO TO MITIGATE RISK

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DISCLOSURES AND JAKE…

- Assistant Professor (*tenured*) of Kinesiology at Texas Tech University
- **Education**
  - Texas Tech University – 2014 – B.S. Exercise and Sport Science
  - Texas Tech University – 2016 – M.S. Kinesiology (*Human Performance*)
  - University of North Carolina at Chapel Hill School of Medicine – 2020 – PhD Human Movement Science
- **Personal**
  - From Ballinger, TX
  - Pervious firefighter in Cisco, TX (2010-2011)
  - Married to Emily; two daughters; loves lifting weights; mega nerd
- **Funding Disclosures *(Current)*:**
  - National Strength and Conditioning Association (NSCA) Foundation

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NSCA® NATIONAL STRENGTH AND CONDITIONING ASSOCIATION FOUNDATION

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DISCLOSURES AND MIKE…

- CEO and Partner, Front Line Mobile Health, PLLC
- **Military Service & Roles:**
  - Retired in 2018; joined FLMH, PLLC same year
- **Education and Research:**
  - Military Trained Aeromedical PA
  - DMSc from Univ of Lynchburg, Cardiology Medicine
  - Higher Degree Research, Bond University, Faculty of HS&M
- **Personal:**
  - Husband, lots of kids (6), Judo, Jiujitsu, Nerd

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AGENDA - BROADLY

1. The 2023 NFPA 1582 aerobic capacity change
2. The *medical* case for aerobic capacity
3. The *operational* case for aerobic capacity
4. What can you do about it

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AEROBIC CAPACITY CHANGES

- NFPA 1582 used an absolute threshold: 12 METs / 42 mL/kg/min minimum to be cleared for full duty
  - 10-11.9 METs
  - 8-9.9 METs
  - <8 METs
- NFPA 1580 replaced that threshold with age- and sex-based percentiles drawn from the general population
  - 50th percentile
  - 35th percentile
- The threshold to pass ***now shifts*** depending on how old and what sex the firefighter is

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AEROBIC CAPACITY CHANGES (*CONT.*)

- Older firefighters can now be cleared for full duty despite aerobic capacity levels the previous standard would have flagged
- Younger firefighters with strong aerobic profiles can be placed in restricted or program categories solely because of how the percentile math works

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AEROBIC CAPACITY = RETURN TO WORK?

- Return-to-work decisions are now complicated by a standard that may clear a post-cardiac-event firefighter based on age-adjusted population rank ***rather than task-specific capacity***

- **One problem:** *The fireground does not grade on a curve*

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AEROBIC CAPACITY AND FIREFIGHTERS

Aerobic capacity and the demands of firefighting is not a new concept …

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Lemon, P. & Hermiston R., (1977). The human energy cost of firefighting. Journal of Occupational Medicine, 19(8), 558562. https://www.jstor.org/stable/45002756

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WHAT IS AEROBIC CAPACITY

- Aerobic capacity (VO_{2max}) is the maximum rate at which the body can take up, transport, and use oxygen during sustained physical effort
- It is expressed in mL of oxygen per kilogram of body weight per minute (mL/kg/min) or as metabolic equivalents (METs)
- It is not fixed - it responds to training and declines with inactivity, aging without exercise, and chronic disease

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HOW IS AEROBIC CAPACITY MEASURED

- Direct measurement via metabolic cart (VO_{2max} test) - the gold standard. Equipment is typically calibrated.
- Estimated from treadmill time or protocol (e.g., Bruce protocol) — common in occupational health settings

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HOW IS AEROBIC CAPACITY MEASURED

- Submaximal tests (step tests, 1.5-mile run, field protocols); used for large group screening and metric tracking
- Non-exercise prediction equations — estimated from age, weight, resting HR, and self-reported activity

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AEROBIC CAPACITY AND HEALTH

- Low physical fitness is an independent risk factor for death — comparable in magnitude to smoking and high blood pressure (Blair, 1989)
- The least-fit men died at 3.4 times the rate of the most-fit men. For women, the difference was 4.6-fold. (Blair, 1989)
- Every 1-MET increase in exercise capacity produces a 12% improvement in survival (Myers et al., 2002)
- Absolute fitness capacity predicts survival better than age-adjusted fitness rank (Myers et al., 2002)

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AEROBIC CAPACITY AND HEALTH
CONTINUED

- High CRF versus low CRF is associated with a 53% reduction in all-cause mortality (Lang, 2024)
- Each 1-MET increase in aerobic capacity is associated with an 11–17% reduction in all-cause mortality risk (Lang, 2024)
- High CRF is associated with a 69% reduction in incident heart failure and a 73% lower cardiovascular mortality among those already living with heart disease (Lang, 2024)

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AEROBIC CAPACITY AND HEALTH
CONTINUED

- A decline in fitness of more than 2 METs increases mortality risk by 74% in low-fit individuals with heart disease and 69% in those without (Kokkinos et al., 2023)
- Even a 1-MET change in either direction begins to shift mortality risk proportionally – WHY ANNUAL TESTING IS IMPORTANT!
- Men who improved from unfit to fit between two examinations reduced their mortality risk by 44% compared to those who stayed unfit (Ross, 2016)

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AEROBIC CAPACITY & FIREFIGHTERS

- Overexertion accounts for approximately 45% of all on-duty firefighter fatalities - approximately 90% of those are due to coronary heart disease
- Fire suppression represents 1–5% of a firefighter's annual professional time but accounts for 32–43% of on-duty coronary heart disease events
- On-duty cardiovascular events are concentrated among the most susceptible individuals - those with underlying disease or excess cardiovascular risk factors

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AEROBIC CAPACITY AND FIREFIGHTERS

CONTINUED

- In a cohort of 968 male career firefighters, fewer than 44% exceeded the NFPA-suggested 12-MET minimum (Baur, 2011)
- Higher aerobic capacity was independently associated with better lipid profiles, lower blood pressure, lower body fat, and lower resting heart rate — even after adjusting for age and BMI. (Gonzalez, 2025)
- 31.8% of the least-fit firefighters were on blood pressure medication versus 4.2% of the most fit — adjusted for age and BMI, the association remained significant (Gonzalez, 2025)

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AEROBIC CAPACITY AND FIREFIGHTERS

CONTINUED

- Metabolic syndrome prevalence in a 957-firefighter career cohort: 28.3%
- Firefighters in the lowest aerobic capacity category had a 51.2% prevalence of metabolic syndrome; those in the highest had 5.2%; a nearly 10-fold difference
- After adjusting for fitness level, age was no longer a significant predictor of metabolic syndrome (Baur, 2012)

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AEROBIC CAPACITY AND FIREFIGHTERS

CONTINUED

- 64% of the least-fit firefighters had at least one abnormal finding on a maximal stress test — compared to 23% of the most fit (Baur, 2012)
- Each 1-MET increase in fitness reduced the odds of ECG abnormalities by 34% and chronotropic insufficiency by 31% - after adjusting for age, BMI, and metabolic syndrome (Smith,2022)
- Higher aerobic capacity is directly associated with fewer calcified plaques in the coronary arteries of older firefighters (Li et al., 2025)
- Low aerobic capacity is the modifiable risk factor that connects all of these findings

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A CONTROVERSIAL PAPER

- One job, one standard: how the revised NFPA standard 1580 alters firefighter fit for duty status across age. (Miller et al. 2025)
- An analysis of 6,000 tests demonstrated that under the new standard, firefighters aged >30 were 27-38x more likely to pass their aerobic capacity requirement than those in their 20s
- What is the greatest non-modifiable risk factor for cardiovascular disease?

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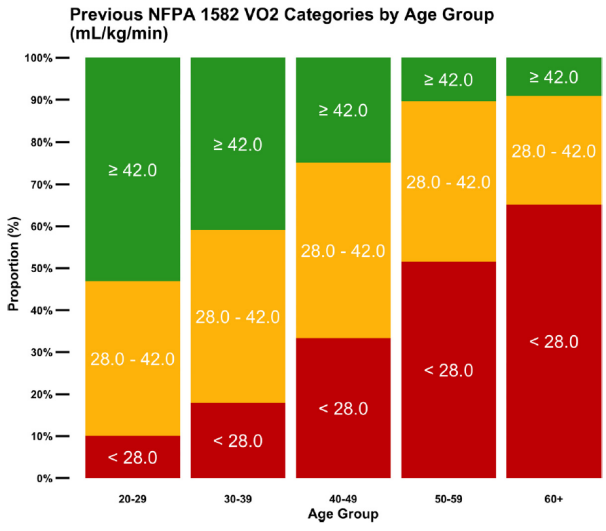
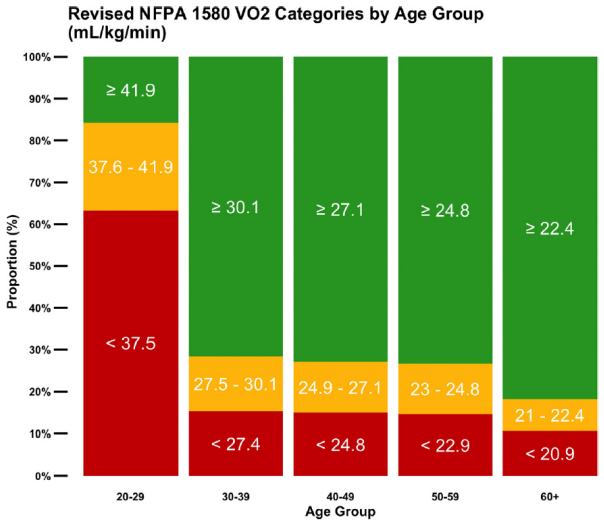
A CONTROVERSIAL PAPER





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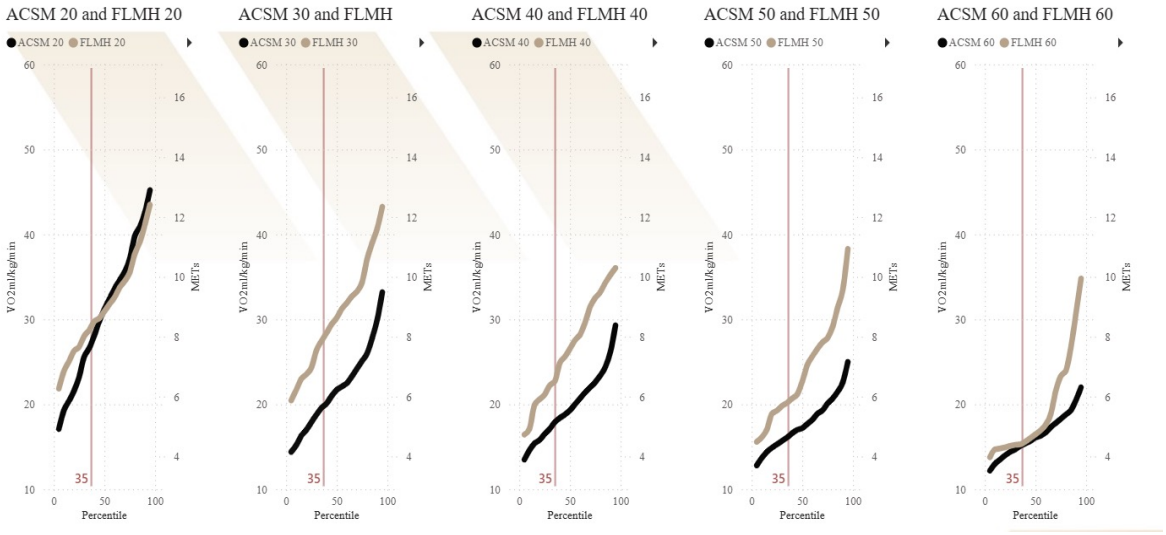
A CONTROVERSIAL PAPER



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SOME CLOSING 'MEDICAL' THOUGHTS

- The American Heart Association has called for cardiorespiratory fitness to be assessed as a clinical vital sign (Ross, 2016)
- The evidence base for occupationally derived fitness standards, not population percentiles, is consistent across decades of fire service research

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SOME CLOSING 'MEDICAL' THOUGHTS

AMERICAN COLLEGE OF OCCUPATIONAL AND

July 22, 2024

Reference to NFPA 1582

The proposed standard extensively quotes National Fire Protection Association (NFPA) 1582, *the Standard on Comprehensive Occupational Medical Program for Fire Departments*,[2] which was updated with changes effective December 20, 2023, and published in November 2023. These changes ended the 12 metabolic equivalents (METs) requirement (which is referenced by OSHA in the proposed rule in the context of NFPA 1582) and created new standards based on age, sex, and disability status. Depending on age and sex, a firefighter may only need an aerobic capacity of 4.3 METs to meet NFPA 1582. ACOEM wants to draw OSHA's attention to this potential discrepancy in the proposed standard.

ACOEM also urges OSHA to consider whether referencing NFPA 1582 in this context is appropriate, as it is unclear if there is any scientific basis in support of these recent changes in NFPA 1582, and these changes have created uncertainty for employers in the context of their alignment with requirements under the Americans with Disabilities Act (ADA) of 1990.[3] In an effort to remedy potential inconsistencies, ACOEM's Task Group on Guidance for the Medical

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Switching gears...

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WE'VE BEEN STUDYING THIS SINCE 1977

- Lemon & Hermiston (1977) - *the original occupational study*
  - Measured energy cost of four most strenuous firefighting tasks:
    - Aerial ladder climb, Victim rescue, Hose drag, Ladder raise
  - 20 male career firefighters, ages 23–43
  - **Results**: firefighting demands 60–80% of VO_2max
    - Even with the effect of heat, smoke, and emotional stress removed
  - Firefighters above 40 mL·kg·min^{-1} met task demands aerobically; those below could not

- **What it established:**
  - The job has a *fixed* physiological cost
  - Nearly 50 years ago, researchers already knew what the job required

- ***The question today is whether our standards still honor that finding.***

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WHY AEROBIC CAPACITY MATTERS TO A CHIEF

- What separates fast vs. slow performers on an air consumption test?
- Aerobic capacity (*Wohlgemuth et al., 2024*)
  - Not age, not BMI, not heart rate
- Firefighters with a higher aerobic capacity use significantly *less* air from their SCBA doing the same tasks
- Task completion time:
  - fast group finished in 6.56 min
  - slow group in 7.74 min
  - a 73-second difference under full gear
- "fast" group used less air *despite* finishing faster.

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TWO DECADES OF RESEARCH TELL US THE SAME THING

- Measured VO_2 during actual firefighting tasks across studies:
  - Range: 23.0 – 43.8 mL·kg·min^{-1}
  - Most demanding tasks: 7.3 – 11.9 METs, with HR at 80–88% of HRmax
- Recommended minimum VO_2max - consistent across four independent research groups:
  - Lemon & Hermiston (1977): task-validated threshold
  - Gledhill & Jamnik (1992): 39.6 – 48.5 mL·kg·min^{-1}
  - Sothmann et al. (1991) and Williams-Bell et al. (2010): same range
- The convergence point across 50 years of research:

42 mL·kg·min^{-1} | 12 METs | Task-validated | Not age-adjusted

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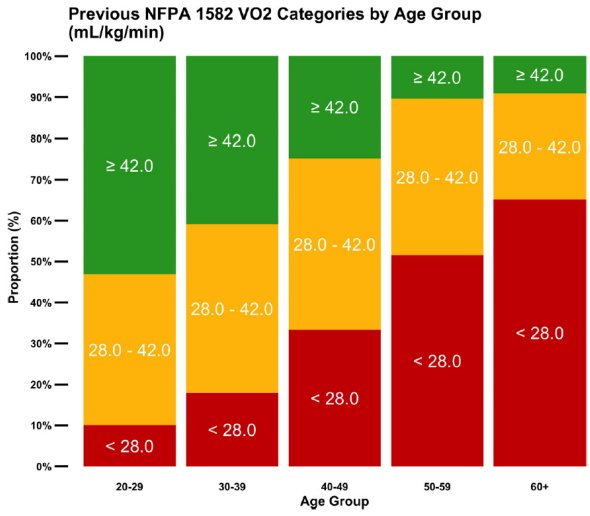
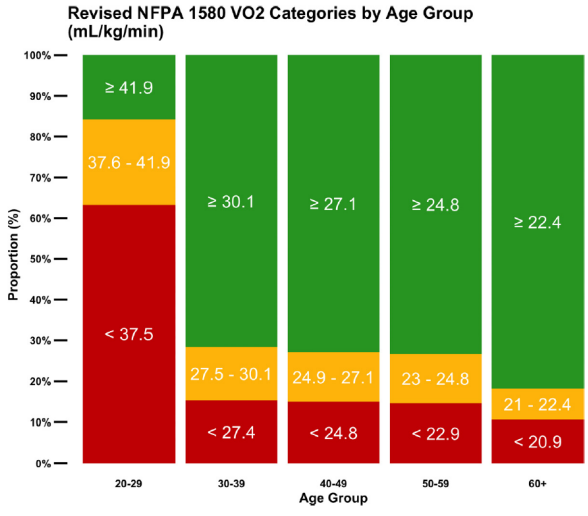
ONE JOB, ONE STANDARD: *OPERATIONAL STAFFING IMPLICATIONS*





Miller et al., 2025, APNM

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ONE JOB, ONE STANDARD:
THE AGE BIAS – BY THE NUMBERS

- Tinsley and colleagues (*2025*) examined 3,867 U.S. firefighters
  - The median VO_{2max} across age = 32 mL/kg/min
  - **10 mL/kg/min ***below*** the 42 mL/kg/min occupational threshold
- Male firefighters aged 20–29 have a median VO_{2max} of 36.3 mL/kg/min
  - Still *below* the NFPA 1580 age-matched standard of 42 mL/kg/min
- Male firefighters aged 30 and older *exceed* the NFPA 1580 threshold by 3.0–3.8 mL/kg/min at every age decade

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ONE JOB, ONE STANDARD:
WHAT THIS LOOKS LIKE IN PRACTICE

	Firefighter A (Age, 24)	Firefighter B (Age, 52)
Aerobic Capacity	44 mL/kg/min	34 mL/kg/min
50th percentile for Age	~48 mL/kg/min	~33 mL/kg/min
Task-validated job demand threshold	42 mL/kg/min	42 mL/kg/min
Outcome Under NFPA 1580	Failed	Classified as unrestricted

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RETURN-TO-WORK (RTW) DECISIONS UNDER 1580

- Under NFPA 1582 (the old standard):
  - Post-cardiac event firefighter must achieve 42 mL·kg·min^{-1} — the absolute task threshold
    - Clear standard. Anchored to critical and essential job tasks
- Under NFPA 1580 (the new standard):
  - Same firefighter must *only* reach the 50th percentile for their age group
  - For the 52-year-old: potentially as low as 33 mL·kg·min^{-1}
  - That's **~9 mL·kg·min^{-1} below the minimum** required for safe suppression
- What the evidence says about this approach:
  - For high-demand occupations, absolute standards independent of age and sex can be legally and medically justified
  - Occupational-specific functional capacity assessment gives physicians and patients a better picture of true RTW readiness

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THE CASE (*OR NOT*) FOR AN ABSOLUTE STANDARD

- Legal and medical justification exists:
  - Absolute standards independent of age and sex are defensible for occupations with documented, fixed physiological demands
  - The fire service meets that threshold — the demands are well-characterized
- What NFPA 1582's 42 mL·kg·min^{-1} actually was:
  - *Not* aspirational — it was a floor
  - *Not* arbitrary — it was task-validated from occupational study data
  - *Not* discriminatory — it reflected what every firefighter faces, regardless of age
  - *Not*…perfect – more research is needed with contemporary firefighting practices
- What population percentiles describe:
  - Aerobic capacity relative to average Americans (i.e., sedentary) — not FF population
  - A 52-year-old at the 50th percentile for their age is *average for a population that doesn't fight fires*

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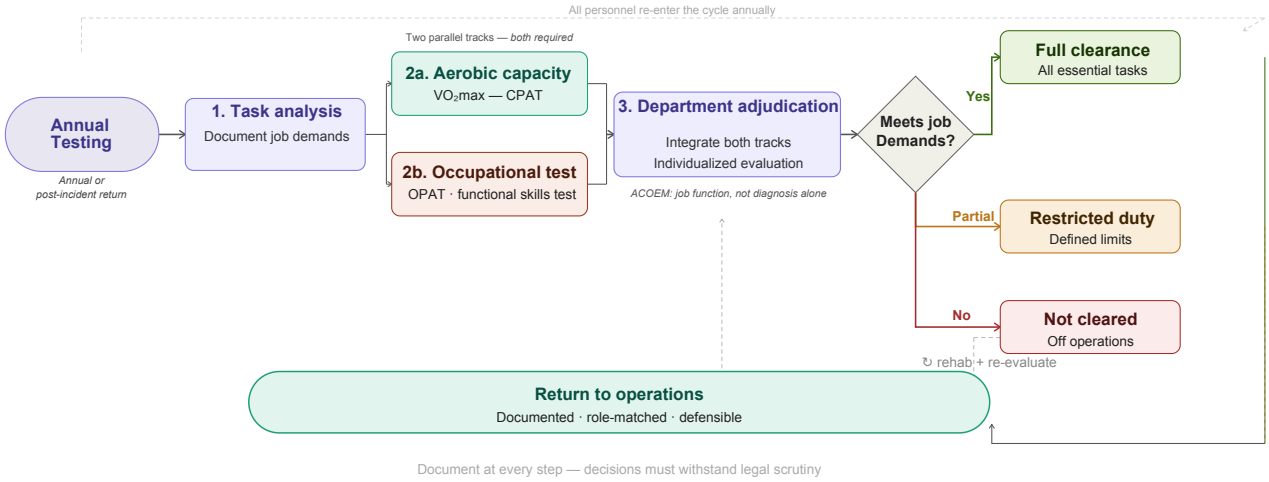
Departmental Adjudication



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What you can do about it

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YOU HAVE THE FINAL SAY

- NFPA standards establish a floor — they do not prevent departments from requiring more
  - Departments may adopt ***more stringent criteria*** than the NFPA minimum
  - The standard doesn't relieve the physician of the obligation to assess real job capacity
- What this looks like in practice:
  - Adopt a local, job-derived threshold (42 mL·kg·min^{-1} or equivalent) as departmental policy
  - Build that policy on documented task analysis for your jurisdiction
  - Require functional capacity evaluation for borderline or post-event cases
- The legal footing exists:
  - Absolute physiological standards for firefighters are legally defensible when tied to documented essential job functions
  - The ADA allows standards that reflect genuine occupational necessity

Document the job. Validate the standard. Own the decision.

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WHAT WE WANT TO LEAVE YOU WITH

- The evidence on aerobic capacity is not in dispute
  - 50 years. 20+ research groups. Consistent answer: 42 mL·kg·min^{-1} / 12 METs
- NFPA 1580's percentile framework creates a systematic, quantifiable misalignment between aerobic capacity classification and fireground demand
  - The data exist. The tools exist. The authority to act is yours.
- Front Line Mobile Health and the TTU Neuromuscular and Occupational Performance Lab are available to help departments build programs that reflect the actual demands of the job
- **Mike Conner** and **Jake Mota** work with fire service leaders across the nation to mitigate risk, reduce operational staffing concerns, and keep communities safe.

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References

- Blair SN et al. Physical fitness and all-cause mortality. JAMA. 1989;262:2395–2401.
- Myers J et al. Exercise capacity and mortality among men referred for exercise testing. N Engl J Med. 2002;346:793–801.
- Ross R, Blair SN et al. Importance of assessing CRF in clinical practice [AHA Scientific Statement]. Circulation. 2016;134:e653–e699.
- Kokkinos P et al. Changes in cardiorespiratory fitness and survival. J Am Coll Cardiol. 2023;81:1137–1147.
- Lang JJ et al. CRF is a strong and consistent predictor of morbidity and mortality. Br J Sports Med. 2024. doi:10.1136/bjsports-2023-107849
- Baur DM et al. CRF predicts cardiovascular risk profiles in career firefighters. J Occup Environ Med. 2011;53:1155–1160.
- Baur DM et al. Metabolic syndrome is inversely related to CRF in male career firefighters. J Strength Cond Res. 2012;26:2331–2337.
- Baur DM et al. Low fitness is associated with exercise abnormalities in asymptomatic firefighters. Occup Med. 2012;62:566–569.
- Strauss M et al. Higher CRF is strongly associated with lower CV risk factors in firefighters. Sci Rep. 2021;11:2445.
- Li M et al. Maximal oxygen uptake and coronary artery calcium scores in firefighters. J Occup Environ Med. 2025;67:e616–e620.
- Miller PE et al. One job, one standard. Appl Physiol Nutr Metab. 2025;50:1–9.
- Conner MJ et al. Aerobic capacity protects against cardiometabolic risk. Transl J Am Coll Sports Med. [In press, accepted March 2026].
- Tinsley GM et al. Reference values for body composition and graded exercise testing in firefighters. J Occup Environ Med. 2025;67:723–[x].
- Wohlgemuth KJ et al. Characteristics of slow and fast performers on a firefighter air consumption test. Appl Ergon. 2024;118:104262.

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QUESTIONS?

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