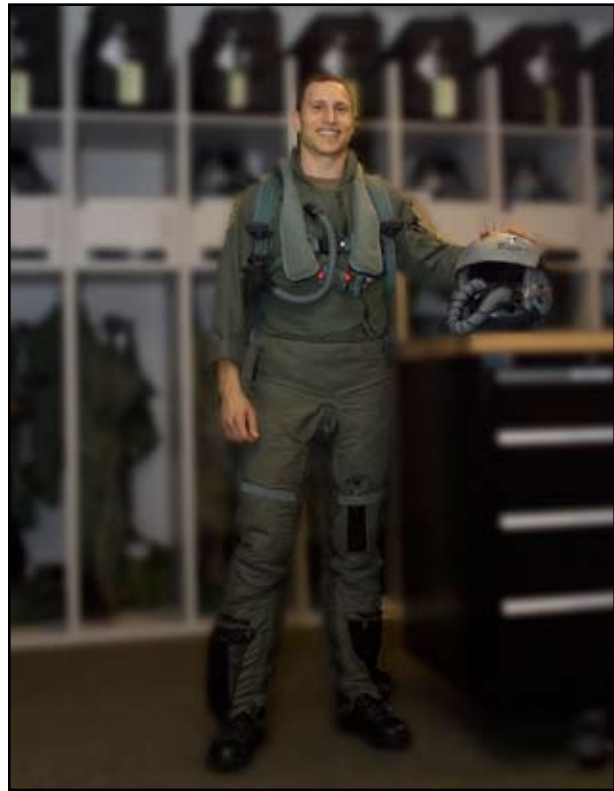


## A New Model For Fighter Pilot Fitness

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The work of a military fighter pilot is often described as long periods of mind-numbing boredom interspersed with short periods of stark terror. While there is hyperbole on both ends of this statement, it's true that there really are innumerable constant threats to the fighter pilot. One of these ever-present threats is the effects of operations in a high G-force environment.

G-Force or "pulling Gs" is the centripetal (and corresponding apparent centrifugal) force on the pilot's body as the aircraft is turned. At rest on the ground, or in 1-G flight, we experience only the force of gravity on our body (9.8 m/s<sup>2</sup>). Pulling Gs effectively increases the pull of gravity on the pilot and the jet. For example, if a 160-pound pilot pulls 8 Gs, he's experiencing 8 times the force of gravity, so he effectively weighs 1280 pounds. The most dangerous aspect of pulling Gs is the pooling of blood in the lower extremities, which can cause G-induced loss of consciousness (G-LOC). G-LOC has claimed numerous pilots' lives. To counter the effects of blood pooling and to minimize the risk of G-LOC, the military uses anti-G garments (G-suits) and teaches pilots a G-straining maneuver that artificially increases blood pressure and maintains a sufficient blood (and hence oxygen) supply to the pilot's brain. The sequence below is a summary of the USAF Pamphlet 11-419 description of how to execute the Anti-G Straining Maneuver (AGSM).



1. Simultaneously flex legs (starting with calves), glutes, and abdominals
2. Take an initial deep breath prior to G-onset
3. Forcibly exhale against a closed glottis
  - a. Exhale small amount of air, then immediately inhale
  - b. Breathing cycle should take half a second
  - c. At peak G, repeat breathing cycle every 3 seconds
4. Sustain upper-body muscle tension as needed until Gs are reduced

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### AGSM and metabolic pathways

It is immediately evident that the AGSM is a full-body exercise, incorporating a primarily lower-body isometric contraction executed in intervals over the period of time when the pilot is under high Gs. In general, for a high-G turning engagement, a fighter pilot can plan on experiencing a rapid onset of 8 to 9 Gs that lasts for about 5 to 10 seconds (think phosphagen metabolic pathway), followed by a sustained 30 to 60 seconds of 4 to 6 Gs (think glycolytic metabolic pathway). The average fight lasts between 90 seconds and 2.5 minutes, with repeated intervals of higher (>5 Gs) and lower (3 to 4 Gs) loading. This fight cycle can be repeated numerous times in a sortie and is very fatiguing. During the fight, the pilot must simultaneously maintain accurate sight of the adversary, awareness of his jet's attitude in relation to the horizon, and the ability to provide smooth, accurate and coordinated inputs to the jet's flight control system. Obviously, consciousness is a prerequisite for these tasks.

Given the requirements for full-body muscle recruitment (particularly in the midline and lower extremities), the stated time duration of the contractions and breath control, and the requirement of both accuracy and coordination, the AGSM practically screams out:

**"YOU NEED INTERVAL TRAINING OF FUNCTIONAL MOVEMENTS IN THE GLYCOLITIC METABOLIC PATHWAY!"**

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*How, then, are pilots currently told to prepare for the demanding high-G environment and how are they evaluated on their ability to survive it?*

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But this is not how pilots are encouraged to train, and it is not how they are evaluated on their physical ability to sustain high Gs. While pilots are periodically assessed on their ability to perform the AGSM mechanics (via post-flight videotape review by a flight surgeon), their actual physical preparedness is rarely assessed. How, then, are pilots currently told to prepare for the demanding high-G environment and how are they evaluated on their ability to survive it?

### Current model

The current Fighter Aircrew Conditioning Test (FACT) protocol is administered during initial fighter aircraft training and after long durations away from flying. It consists of five "strength" and two "endurance" exercises. The loading for the strength exercises is a function of the pilot's body weight (higher weight = higher load). The pilot is asked to perform repetitions on a count of five (two seconds for contraction of the exercise, then three seconds to return to start position). The pilot is assessed based on the number of reps he can perform at this weight and slow-count execution before failing to complete the movement or keep on the interval. A minimum of 50 total reps is required for the strength exercises (a minimum of 10 reps on each exercise, with a maximum score of 15 reps per exercise). The strength exercises are all executed on machines, with one minute of rest between each exercise:

- Seated biceps curl
- Pec station (chest press)
- Lat pull-down with elbows adducted (narrow grip)
- Supine leg press (lying on a machine that guides the path of the movement)
- Prone hamstring curl

Before moving on to the "endurance" exercises, let's evaluate the strength exercises. Notice the trends:

- The movement paths are restricted by the machines (and therefore require little stabilization).
- The majority of movements recruit only one joint.
- The majority of movements recruit only one major muscle group.
- None of the movements require coordination or accuracy.
- None of the movements require midline stabilization (the lat pull-down may be somewhat debatable).
- The biceps curl, prone hamstring curl, and chest press have very little, if any, application in the actual G-strain execution.
- The timeframe of execution does not challenge either the phosphagen or glycolytic pathways.

In summary, all of these are non-functional, isolated movements that do not challenge the glycolytic pathway and that do not require coordination or accuracy. In other words, they are the exact opposite of the demands of actually performing the AGSM.

Now for the “endurance” exercises. These require the pilot to execute one minute of push-ups and one minute of “quarter crunches” for max reps (up to 50), with rest between each exercise. Finally, the pilot does one minute of bodyweight supine leg presses on the machine for reps (20 minimum, 50 maximum).

The push-ups require some midline stabilization, but they do not otherwise test a muscle group required for a successful AGSM. The “quarter crunch” is executed with the feet up on a bench to put the hips and knees at a 90-degree angle. This limited range-of-motion flexion of the abdominals does not come close to assessing how the abdominals (much less the entire core) function in execution of the AGSM. The faults of the supine leg press have already been addressed above. The only useful quality of this final portion is that the pilot is forced into the glycolytic metabolic pathway for the one-minute duration of the test.

Clearly, there is a significant disconnect between this assessment of a pilot’s physical preparedness for high Gs and the actual execution of the AGSM used to sustain consciousness during high-G maneuvering.

The problem is that the FACT determines the recommended physical training (PT) for pilots. Because the FACT is misdirected, the recommended PT for pilots is also misdirected. This scenario is symptomatic of the systemic “dumbing-down” of physical training to the most segmented, least skill-based, and, frankly, least functional denominator. A sample recommended fighter pilot workout is shown below:

### Existing recommended (non-functional) fighter pilot physical training

Warm-up: 10-15 minutes

- Dumbbell chest fly
- Lateral raise
- Lat pull-down
- Triceps press
- Biceps curl
- 4-way neck press

Core Workout: 30-40 minutes

- Leg extension
- Leg curl
- Quarter squat
- Toe raise
- Flutter kick (supine)
- Flutter kick (prone)
- Bent-leg crunch

Aerobic Training: 20-30 minutes

- Intervals on treadmill, bike, or elliptical trainer

Note the repetition of the same trends that we saw in the “strength” exercises of the FACT. Also, note the amount of time required to complete the workout (60 minutes minimum, 85 minutes maximum). The average fighter pilot’s workday is in excess of 12 hours; there is not much time to fit in an extra hour or more of PT. The instructions in AFPAM 11-419 guide pilots to use weights at certain percentages of their one-rep max. The pamphlet then provides three workout models: strength and power, endurance resistance, and high-intensity circuit training (page 14). These models simply vary the rest period between the same exercises listed in Figure 2, with a goal of increasing weight and decreasing rest periods from between 1.5 and 2 minutes all the way down to 30 seconds (a la classic non-functional circuit training).

So, what does *this* fighter pilot recommend instead?



### Proposed improved model

I say let the functional requirement (effective AGSM maneuver at intervals while demanding coordination and accuracy) drive the PT program, and let the FACT model assess the PT. What the PT model should be is easy to determine in the eyes of this CrossFitting fighter pilot: Do CrossFit. Constantly varied functional movements executed at high-intensity and requiring midline stabilization, core-to-extremity movement and control, and the demand for strength, endurance, accuracy, and coordination is a perfect model for AGSM preparation. So, how to test it?

A better FACT would use high-intensity exercises that incorporate midline stabilization demands. It would require accuracy and coordination, and would force the pilot to execute the exercises at intervals that tax the glycolytic pathway. The tested exercises must be relatively easy to teach and safe to execute. My recommended FACT, then, is outlined below:

### Proposed improved (functional) fighter pilot physical training test

For maximum total reps of each exercise, performed in immediate succession:

- 20 seconds deadlift  
(loading = 1.25 x body weight)
- 20 seconds barbell hang power clean  
(loading = 0.75 x body weight)
- 10 seconds rest
- 15 seconds deadlift  
(loading = 1.25 x body weight)
- 15 seconds barbell hang power clean  
(loading = 0.75 x body weight)
- 10 seconds rest
- 30 seconds of air squats (no load)
- REST 3 minutes
- Work Cycle 2
- Repeat Work Cycle 1

In this model, the total time of load in each work cycle is 100 seconds broken into three intervals of work separated by 10 seconds of rest. This closely models the timeline of G-loading during a fighter engagement (as described at the beginning of this article). The 3 minute rest is representative of the timeline between engagements. The second cycle models another fight requiring the same G-loading. The deadlift requires



Nicole of CrossFit Hampton Roads demonstrates the deadlift and hang power clean.

midline stabilization and demands recruitment of the majority of major muscle groups actually used during the AGSM. The loading is relatively light, but it is sufficient for testing applicable strength and stamina over the timeframe of execution. If the pilot can maintain midline stabilization throughout the deadlifts, he can maintain isometric contraction of the abdominals and spinal erectors throughout the AGSM. The hang power clean requires coordination and accuracy in timing and requires the pilot to receive the bar in a stabilized position. Finally, the squat combines both elements in a glycolytic timeframe. The overall scoring based on max reps forces speed and power (athletic qualities that actually help prepare the pilot for an athletically taxing AGSM). The exercises are teachable to a sufficient level in a matter of hours, or less.

The most positive element of this FACT is its potential to change the PT mentality of fighter pilots. Currently, at the earliest stages of their training, young fighter pilots are taught the exercises for the FACT and given a non-functional fitness protocol (as listed above) to follow. Although the deadlift and clean seem daunting, a new class of fighter pilots can be taught basic functional movements (squat, front squat, overhead squat, shoulder press, push press, push jerk, deadlift, SDHP and clean) in the same allocated time it takes to teach them the current FACT exercises and fitness model (about a 2-3 hour course, then 3-5 hours a week of dedicated fitness training time). They are now on a path to efficient and effective fitness development (not to mention the multitude of other benefits of functional movements), in addition to preparing for the test. Replacing the Globo-gym treadmill and biceps curl/bench press/hamstring curl routine will give the pilots focus within an efficient and effective protocol to prepare them for the high-G environment.

### Summary

The AGSM is an athletically taxing maneuver requiring strength, endurance, accuracy, and coordination executed in intervals within the glycolytic metabolic pathway. The current methods of physical training (PT) and physical assessment (the Fighter Aircrew Conditioning Test) are not sufficient for preparation or evaluation of a pilot's ability to effectively sustain the AGSM in a high-G environment. A more effective physical training model for fighter pilots is a CrossFit-based PT regimen, accompanied by assessment with a revised FACT that directly tests the actual physical requirements of the AGSM over a fighter engagement timeline.



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