

Does aerobic fitness ($\text{VO}_{2\text{max}}$) affect the performance of a fire-fighter during realistic hot fire training (RHFT)?

Research conducted at GMFRS T&DC

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Aim of the study

- During RHFT does $VO_{2\max}$ have an influence on:
- Heart rate
- Core temperature
- Air consumption
- Time to complete the task.

Limitations

- Number of personnel used
- Not clinical (not individual, sterile)
- *No strength measurements taken*.

Strengths

- Realistic conditions
- Worked in teams of 2
- Realistic 'casualty'
- Replicable
- Good range of personnel.

The study

- Volunteers n = 14 (10m, 4f)
- Height 175 cm (SD \pm 6.5) range 165 – 191
- Mass 82.2 kg (\pm 12.1) range 68.6 – 110.7
- Body fat 23.4% (\pm 4.7) range 14.5 – 31.3.

MSSRT

- To measure $\text{VO}_{2\text{max}}$ and MHR
- = $44.9 \text{ ml.kg}^{-1}.\text{min}^{-1}$ (± 6.4) range 37.1 - 57.6
- = 3.67 l.min^{-1} (± 0.58) range 2.98 - 4.65
- MTHR = 179 (± 9) range 167 - 194
- MHR = 181 (± 9) range 166 - 194.

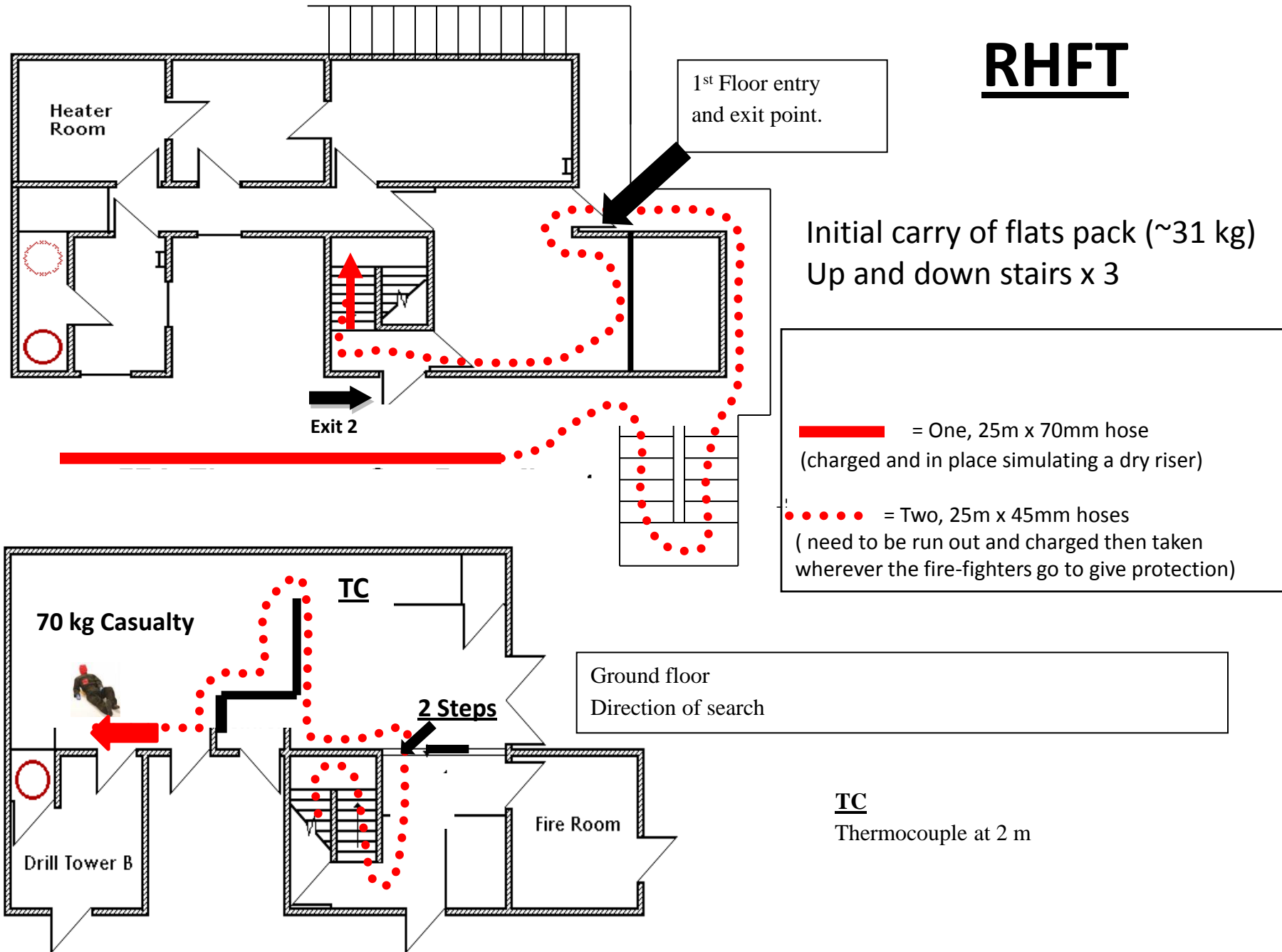
RHFT

- Teams of 2
- Full PPE ~ 10 kg
- SCBA ~ 16 kg (not 'under air' initially)
- Carry a flats pack ~ 31 kg up to the 2nd floor and back x 3 (total ascent - 19.56 m, descent - 19.56 m)
- Go 'under air' and run out two 25 m x 45 mm hose ~ 8 kg per hose (1 each)
- Hose charged ~ 40 kg
- Drag this charged hose (2 x ~ 48 kg per hose) whilst performing search and rescue.

RHFT

- GMFRS policy that teams must always have water, therefore hose must be with them at all times
- to 1st floor = 3.4 m ascent
- To entry point = 9 m horizontal
- To the staircase = 8.5 m horizontal
- Descend internal stairs = 3.1 m
- To the casualty = 15 m horizontal distance (including further 2 stair descent = 0.3 m)
- Retrieve casualty = 15 m horizontal distance (including further 2 stair ascent = 0.3 m)
- Return to entry door.
- Total 56 m (H), 6.8 m (A), 3.4 m (D).

RHFT





RHFT

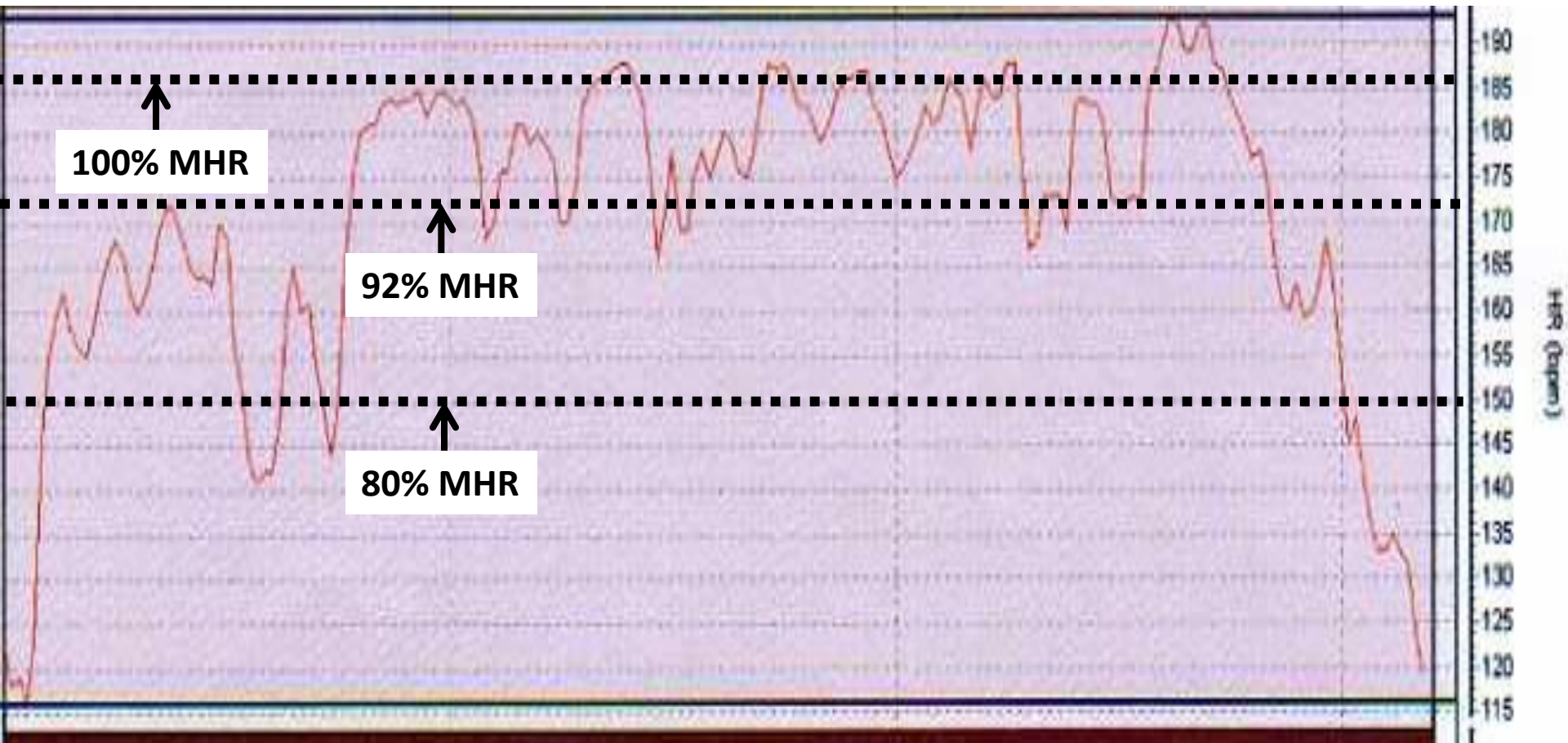
- BAI followed each team
- Temp between 145 and 150°C (thermocouple at 2 m)
- CT measured via tympanic Braun Thermoscan IRT 4520 before and immediately after the RHFT
- HR's taken via Suunto T4 HRM for duration of MSSRT and RHFT
- Body fat measured via Omron BF300
- Air consumption measured via calculation of SCBA cylinder contents used.

Results

- **Heart rates:**

- Average = 92% (± 8) range 72 – 101%
- MTHR = 179 (± 9)
- MHR (RHFT) = 184 (± 12)
- 10 participants above MTHR (Highest = + 18 x 2)
- What do you think after the stair climb?
- 65 – 75%? 75 -85%? 85 – 95%?

After the stair climb



Results

- **Heart rates:**

- Average = 92% (± 8) range 72 – 101%
- MTHR = 179 (± 9)
- MHR (RHFT) = 184 (± 12)
- 10 participants above MTHR (Highest = + 18 x 2)
- What do you think after the stair climb?
- 65 – 75%? 75 -85%? 85 – 95%?
- = 90% (± 6) range 71 – 95%
- **No significant correlation with VO_{2max}**
- MHR for MSSRT & RHFT, very large significant correlation of ($r = .819$; $p , 0.001$)

Results

- **Core Temperature:**

- Pre = 36.1° (± 0.7) range 35.2 – 36.9 $^{\circ}$
- Post = 39.0° (± 0.7) range 38.3 – 39.9 $^{\circ}$
- Change = 3.0° (± 0.7) range 1.7 – 4.3 $^{\circ}$
- **No significant correlation with $\text{VO}_{2\text{max}}$.**

Results

- **Air consumption:**

- 78.70 l.min⁻¹ (± 9.9)
- Lowest 64.29
- Highest 97.11
- Haldane's theory (40), Latest theory (55)
- The need for telemetry!
- **No significant correlation with VO_{2max}.**

Results

- **Time to complete the scenario:**
 - From time 'under air'
- 24min 32s (\pm 2.26)
- shortest 21.22
- longest 28.41
- 3 teams did not complete the RHFT properly
- **Moderate correlation with VO_{2max}** (ml.kg⁻¹.min⁻¹) (r = -.415)
but not at (P < 0.05) level
- **Large correlation with VO_{2max}** (l.min⁻¹) (r = -.589; p < 0.027)
- Time essential to save life!

Other considerations

- **Body composition:**

- No effect on H.R, C.T or air consumption
- Moderate correlation with time ($r = .409$)
- Very large correlation with VO_{2max} ($\text{ml.kg}^{-1}.\text{min}^{-1}$) ($r = -.831$; $P < 0.000$)
- Small correlation with VO_{2max} (l.min^{-1}) ($r = -.188$).

Other considerations

- **Age:**

- Decline in $VO_{2\max}$ ($\text{ml.kg}^{-1}.\text{min}^{-1}$) ($r = -.426$)
- No decline in $VO_{2\max}$ (l.min^{-1}) ($r = -.064$)
- Large correlation with rise in C.T ($r = .553$; $p < 0.04$).

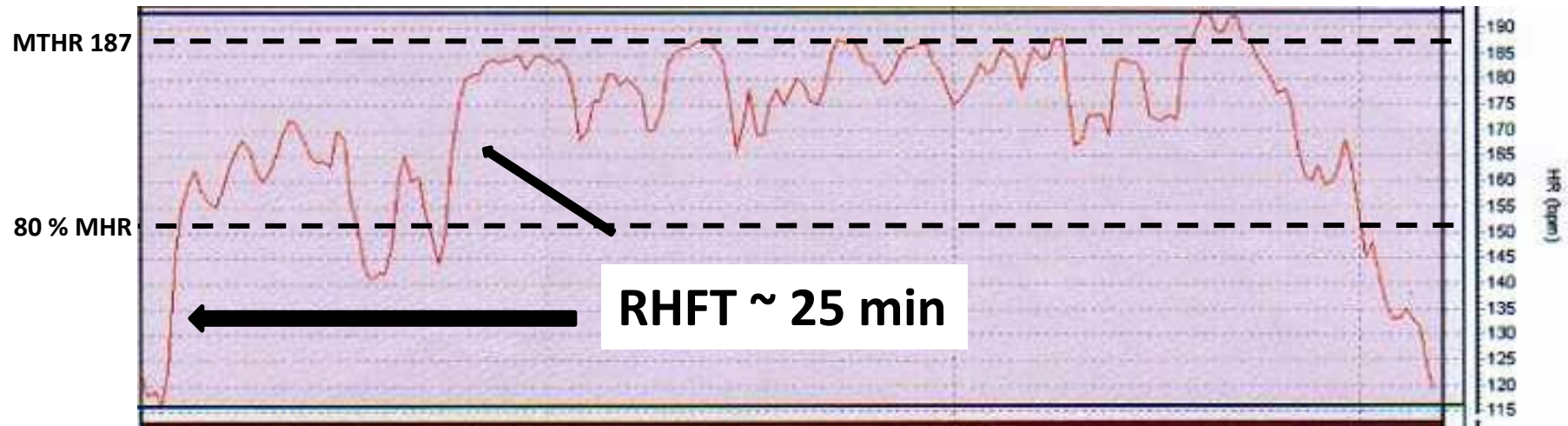
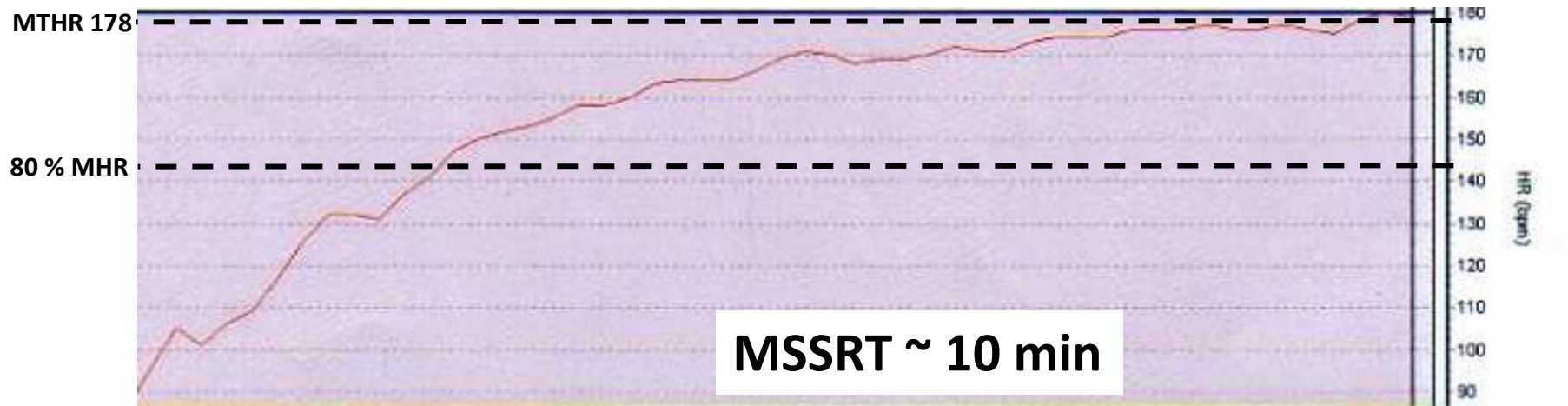
Other considerations

- **Strength:**

- The participants stated via questionnaire that strength was a major factor of the RHFT
- 3 teams failed to complete the RHFT the teams included all 4 females
- These 3 teams were also the slowest
- The females were evenly distributed in regard to their $VO_{2\max}$ ($\text{ml}\cdot\text{kg}^{-1}\cdot\text{min}^{-1}$) and ($\text{l}\cdot\text{min}^{-1}$).

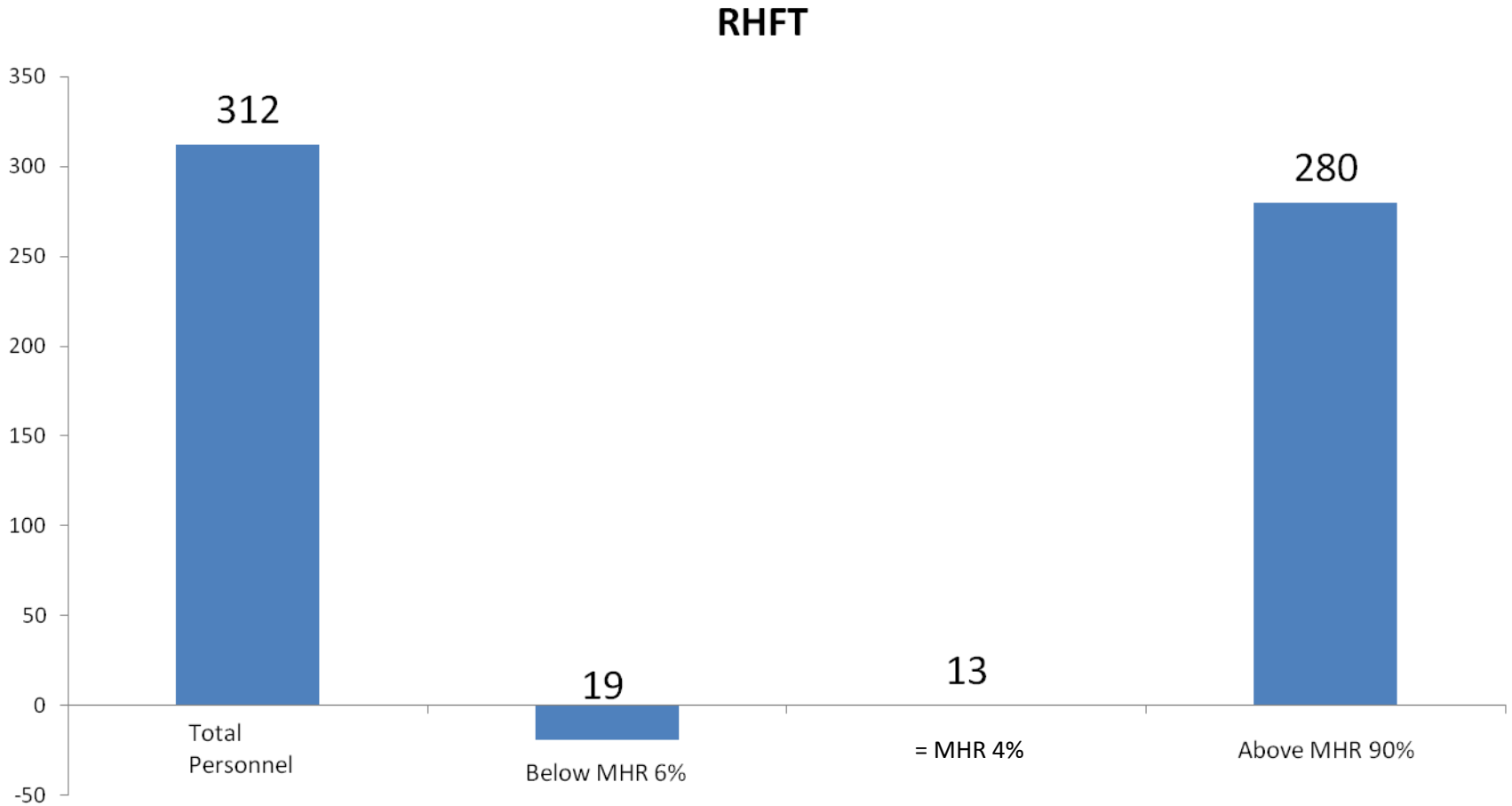
Fitness testing MSSRT?

- H.R comparisons



RHFT in Service

First 312 through 1 day BA.



Conclusions

- The importance of VO_{2max} is well documented.
- It should not be a 'stand alone' measure of fire-fighter fitness
- Further research into legally defensible role related tasks are essential (FFSG?)
- Strength of all fire-fighters irrespective of age or gender needs to be maintained

Thank you for listening

Any Questions

