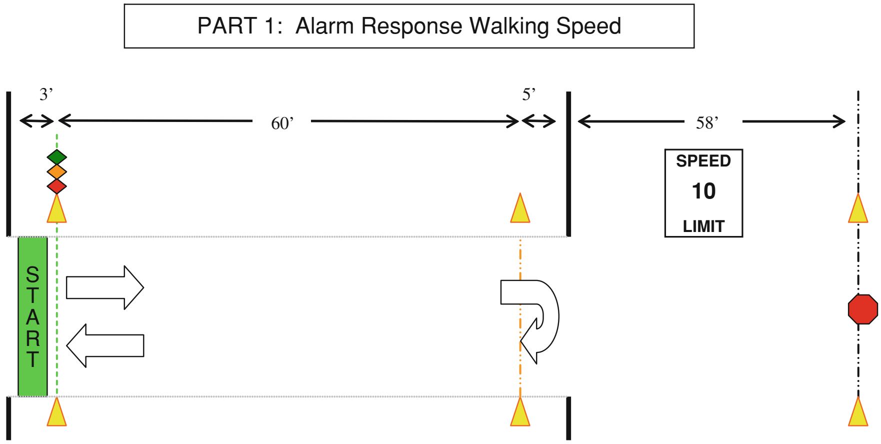
Appendix A
Standardized Ideal "Turn Out" Time Drill Layout



This layout can be reproduced in many typical fire station apparatus bays[1]. This provides a protected indoor environment suitable for measuring firefighter movement speed in a simulated alarm response. The distance from the start and return lines should be measured with a measuring tape or surveyor's wheel as accurately as practical. The start and return lines should be clearly marked. Traffic cones can be used to mark the lines but taped lines on the floor allow for more reliable timing.

[1] If the station used does not have room for the full 60′ long course, a 30′ course may be substituted with two laps being completed instead of a single lap. If the alternative layout is used, it must be documented on the data collection form.

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Time over this measured distance will be averaged with data from other departments to estimate an objective movement rate which, in turn, can be used to calculate travel times for various fire station layouts.

Data to track per each trial:

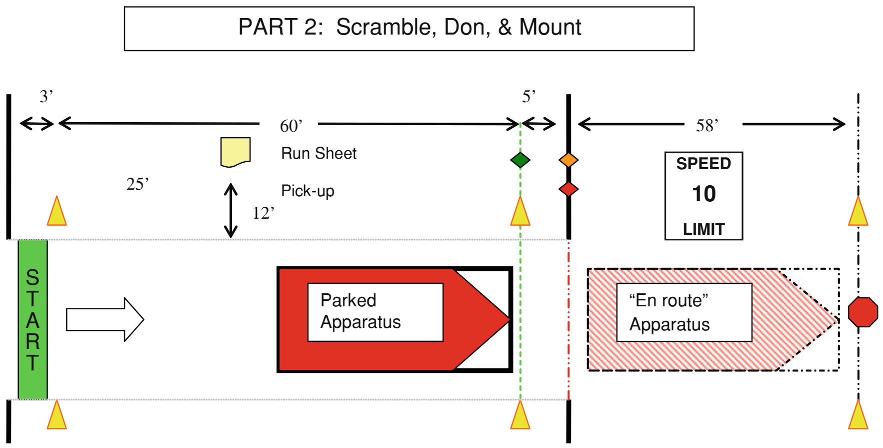
- Trial Identification (date, number)
- Unit Identification (Type, Number, Shift)
- Crew size
- Accurate course completion time for the first and last crew member

A.1 Alarm Response Walking Speed Procedure:

1. The crew moves "quickly and with purpose;" *no* jogging or running; "As you would normally respond to an emergency call in your station."
2. The crew starts on "ready, set, go" command.
3. The crew proceeds to the front end of the bay; crosses over the measured line return; returns and crosses over the starting line to finish. (See footnote 1 for alternate layout)
4. Using a stopwatch, record times for the first and last crew member over the finish line. (If the entire crew crosses the line too closely to reliably time both first and last, record the first time only.)

A.2 Alarm Response Walking Speed Briefing Points

- Move "quickly and with purpose as you would normally respond to an emergency call in your station"
- NO RUNNING OR JOGGING
- Start will be "ready, set, go"—step off quickly



This layout can be reproduced in many typical fire station apparatus bays[2]. It provides a credible simulation of a typical fire station environment with crews in the space immediately adjacent to the apparatus. The close proximity of the crew provides a "best case" scenario which should supply a minimum value for "turnout time."

Split times should be recorded for two possible interpretations of the "en route" criteria:

Data to track per each trial:

- Trial Identification (Date)
- Unit Identification (Type, Number, Shift)
- Crew size
- Time to each "en route" criteria

1. "wheels rolling" measured as soon as the apparatus starts moving
2. "front crosses sill" measured when the front of the apparatus crosses the bay door sill

[2] If the station used does not have room for the full 60′ long course, a modified course may be substituted by starting the crew even with the apparatus front bumper on the driver's side and moving to the rear bumper (minimum 30′) before returning and mounting the apparatus instead of the regular layout. If this alternative layout is used, it must be documented on the data collection form.

A.3 Scramble, Don, and Mount Procedure

1. Starting configuration

- "Le Mans Start"—Crew starts shoulder to shoulder in a line facing away from the apparatus at the back of the bay
- Crew is dressed in regular station wear
- PPE is stowed at each crew member's riding position[3]
- Apparatus is parked with its front 5′ from the line of the door sill
- MPO & Officer's windows are open
- Apparatus is otherwise as it would normally be stowed in station

2. On command ("Go!", *no* countdown preparation)

- *Timer must be positioned to observe "wheels rolling" safely before MPO can release brakes!*

3. Special Tasks

- Officer retrieves "Run Sheet" from simulated printer
- MPO opens bay door (manually or with remote)

4. Crew moves promptly to gear; all crew members don core gear at minimum (See footnote 3)

- Bunker pants
- Boots
- Flame retardant hood (*if normally worn)*
- Bunker coat
- Helmet (*or headset if that is standard practice*)

5. Crew mounts apparatus

- MPO may start engine at any time

6. Crew will *not* don SCBA per consensus of technical advisors
7. Crew fastens seatbelts

- Seatbelt compliance confirmed by apparatus officer
- MPO shall not release brakes until compliance confirmed

[3] EMS crews may omit PPE as per local SOP. Fire suppression crews must don full PPE including either a helmet or radio headset.

8. MPO pulls straight forward promptly (Maximum Speed 10 mph)
   - Brakes released; wheels start (**Split 1**)
   - Front Bumper crosses doorway sill marked by traffic cones (**Split 2**)
   - MPO must *stop* before reaching curb line marked by traffic cones[4]

A.4 Scramble Don, and Mount Briefing Points:

- PPE stowed at each crew member's riding position
- MPO & Officer's windows open
- Apparatus as normally stowed
- Regular station wear *as normally worn*
- "Le Mans Start"
  - Facing away
  - No warning for starting "Go!"
- NO RUNNING OR JOGGING
- Officer retrieves "Run Sheet"
- MPO opens bay door
  - MPO may start engine at any time
- Core gear
  - No SCBA
- Crew fastens seatbelts
  - Compliance confirmed by officer
  - MPO waits for confirmation
- MPO pull forward promptly (10 mph max)
  - *stop* before reaching curb line

[4] Where the proximity of public sidewalks and streets limits the distance the apparatus can continue out of the bay, appropriate modifications should be made. Please note any such modifications on the data collection sheet.

Appendix B
Treatment of Extreme Outliers in the Mobilization Study Historical Data

When all the historical response data from our 14 participating departments was in, we had collected over half a million individual response records. All of these records could not simply be aggregated together due to variations in the ways different departments documented the various time segments critical to our study.

Only data from departments having complete mobilization data—starting with the time the call for assistance was answered, through the time appropriate Emergency Response Units (ERUs) were dispatched, until ERUs were "En route"—was combined. This yielded slightly over 1,53,000 raw data records.

Because of the retrospective nature of the study, it was considered impractical to research individual response records containing what appeared to be idiosyncratic data. To this end, some gross filtering was required on the data prior to analysis. Records where either the Call Processing time or the Turnout Time was recorded as less than or equal to zero were omitted outright as artifacts or documentary errors. It is assumed that these records typically reflect incidents where an ERU came upon an incident without prior dispatch, one incident branched from another, etc. and an incident record was created after the fact.

The second and more difficult to manage concern was for extreme outliers at the upper range of data. In the Call Processing data, for instance, the longest processing time for a fire call was reported at 3,946 s; over 1 h and 5 min! The longest reported processing for an EMS call was not far behind at 3,565 s or just over 59 ½ min. While it is conceivable that some of these extreme outliers represent legitimate Call Processing Times for legitimate emergencies it seems more credible to assume that many of them represent artifacts and non-emergent incidents. The difficult question becomes, which of these extreme outliers can be omitted from the data set to give the most accurate and useful picture of normal Mobilization Times without losing valuable descriptive data?

Figure 1 illustrates graphically the distribution of response data for Call Processing Time for 137,770 fire and EMS responses combined. Only those

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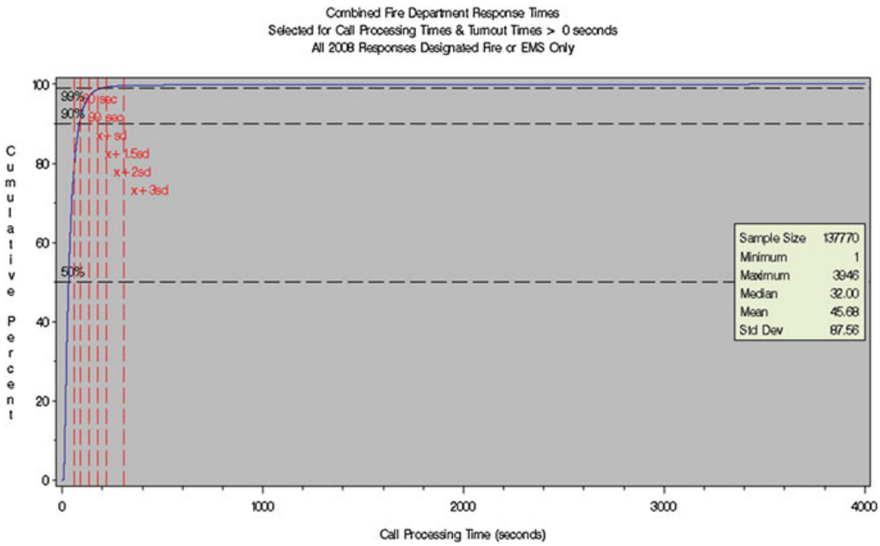

Fig. B.1 CDF combined fire & EMS call processing time (unfiltered)

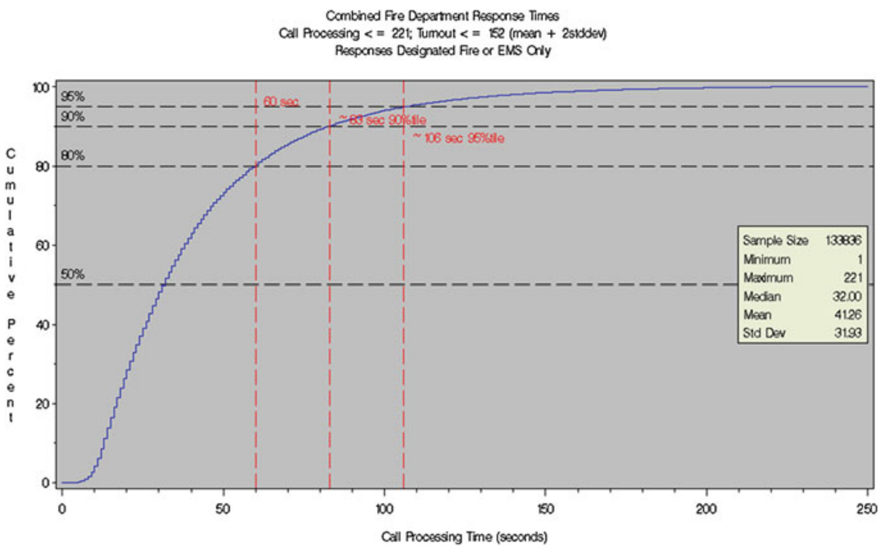

Fig. B.2 CDF combined fire & EMS call processing time

records where Call Processing Time or Turnout Time were less than or equal to zero were omitted in creating this cumulative distribution function (CDF) graph. Starting at the lower left corner at 0 % and 0 s, a blue line representing the cumulative percentage of observed processing responses completed, shown on the

Table B.1 Call Processing Time/Fire (raw)

Fire calls n = 22,564	NFPA 1221 benchmark criteria	Observed compliance	Median Mean Max
Call processing	60 s 90 % 90 s 99 %	79 % 92 s 90 % 315 s	29 56 3946

Table B.2 Call processing time/fire (filtered)

Fire calls n = 21,954 (610 outliers omitted)	NFPA 1221 benchmark criteria	Observed compliance	Median Mean Max
Call processing	60 s 90 % 90 s 99 %	80 % 88 s 91 % 210 s	29 43 404

Table B.3 Call processing time/EMS (raw)

EMS calls n = 115,206	NFPA 1221 benchmark criteria	Observed compliance	Median Mean Max
Call processing	60 s 90 % 90 s 99 %	80 % 84 s 92 % 182 s	32 44 3565

Table B.4 Call processing/EMS (filtered)

EMS calls n = 110,708 (4478 outliers omitted)	NFPA 1221 benchmark criteria	Observed compliance	Median Mean Max
Call processing	60 s 90 % 90 s 99 %	81 % 79 s 93 % 134 s	32 40 154

vertical axis, is plotted against time, shown on the horizontal axis. The line rises quickly to the median average, 50 % of observed responses, in just 32 s, reaching 90 % of observed responses in just over 90 s, and 99 % of observed responses in a little over 300 s. The last 1 % of the observed responses requires most of the graph for a range of about 3,700 s—over an hour represented in a long "tail" to the right of the otherwise typical CDF of a typical normal distribution.

$$t_{CP} > 0 \,\&\, t_T > 0$$

Table B.5 Turnout time/fire (raw & filtered)

Fire calls n = 22,564	NFPA 1710 benchmark criteria	Observed compliance	Median Mean Max
Turnout	80 s 90 %	60 % 123 s	71 75 2629
Fire calls n = 21,954 (610 outliers omitted)	NFPA 1710 benchmark criteria	Observed compliance	Median Mean Max
Turnout	80 s 90 %	61 % 119 s	71 72 172

Table B.6 Turnout time/EMS (raw & filtered)

EMS calls n = 115,206	NFPA 1710 benchmark criteria	Observed compliance	Median Mean Max
Turnout	60 s 90 %	54 % 109 s	58 63 3112
EMS calls n = 110,708 (4478 outliers omitted)	NFPA 1710 benchmark criteria	Observed compliance	Median Mean Max
Turnout	60 s 90 %	55 % 103 s	57 60 147

The red vertical lines overlaid on the graph indicate the mean average times of observed responses, 46 s, plus various multiples of the standard deviation of 88 s (mean plus 1, 1 ½, 2, and 3 standard deviations) as various candidates for initial cutoff filtering of extreme outliers.

The mean average plus 2 standard deviations, 221 s in this example, was chosen as an initial cutoff filter for comparison. In a normal distribution, this would omit 2.28 % of the data. A CDF of the same data omitting responses where either the Call Processing Time or Turnout Time exceed the mean plus 2 standard deviations of the raw data is shown in Fig. 2. The filtered data produces a more visually informative graph, retains its original median value, and arguably represents a more credible range of processing times for actual emergencies.

$$t_{CP} > 0 \,\&\, t_T > 0$$

$$t_{CP_{filtered}} \leq (\bar{x}_{CP_{raw}} + 2S_{CP_{raw}}) \& t_{T_{filtered}} \leq (\bar{x}_{T_{raw}} + 2S_{T_{raw}})$$

B.3 Raw versus Filtered Data

Analyzing 22,564 raw fire response records yields the results shown in Table 1. In this analysis, 79 % of the observed fire responses meet the 60 s NFPA 1221 benchmark for call processing and 90 % meet the 90 s benchmark. The median average, representing 50 % of all calls, is 29 s.

Applying a mean plus 2 standard deviation filter in Table 2 omits 610 response records or about 2.7 % of the total. The changes in the calculated compliance times and percentages only shift by 1 s and 1 % respectively with no change in the median average.

Performing a similar analysis on 115,206 raw EMS response records yields the results shown in Table 3. In this analysis, 80 % of the observed EMS responses meet the 60 s NFPA 1221 benchmark for call processing and 92 % meet the 90 s benchmark. The median average, representing 50 % of all calls, is 32 s.

Applying a mean plus 2 standard deviation filter in omits 4478 response records or about 3.9 % of the total. Once again, the changes in the calculated compliance times and percentages only shift by 1 s and 1 % respectively with no change in the median average as shown in Table 4.

The same pattern can be observed with Turnout Time for raw versus filtered fire response calls in Table 5 and also with Turnout Time for raw versus filtered fire response calls in Table 6.

As the only other measure taken from the Historical Response Data, Mobilization Time, is created by summing Call Processing Time and Turnout Time, it shows the same stability when comparing raw and filtered statistics.

Because the filtering of data only presumably removes some artifacts and atypical outliers at the expense of also presumably removing some valid information, there should be a clear benefit to justify doing so. No such benefit was found with respect to this study with the exception on using filtered data for the creation of CDF plots in order to magnify the critical areas of the plot and minimize the data “tail” created by extreme outliers.

About The Authors

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Robert Upson is a graduate student at the Worcester Polytechnic Institute (WPI), where he is pursuing a Master of Science degree in Fire Protection Engineering. Upson is currently developing his thesis project on a comprehensive analysis of fire service turnout time. He successfully authored and managed an Assistance to Firefighters Grant for $73,000 in 2007 for his fire department's public education program. Prior to entering the fire service, Upson worked as a database manager and research assistant for a large university research project. Upson recently completed data collection for a pilot study on fire service turnout times in Montgomery County, MD, as an adjunct to the ongoing "Multi-Phase Study on Firefighter Safety and Deployment of Resources." Upson holds a B.A. in Psychology from the University of Connecticut, a B.S. in Fire Science Technology from Charter Oak State College, New Britain, CT, and numerous fire service professional certifications. He is currently a deputy fire marshal and career firefighter with over 25 years on the job.

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