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Estimating the Travel Time of Fire Apparatus

Dear Reader:

The following document was created from the MTAS website (mtas.tennessee.edu). This website is maintained daily by MTAS staff and seeks to represent the most current information regarding issues relative to Tennessee municipal government.

We hope this information will be useful to you; reference to it will assist you with many of the questions that will arise in your tenure with municipal government. However, the *Tennessee Code Annotated* and other relevant laws or regulations should always be consulted before any action is taken based upon the contents of this document.

Please feel free to contact us if you have questions or comments regarding this information or any other MTAS website material.

Sincerely,

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MTAS-1936

Travel time is one of the components of total response time for an incident. On most emergency incidents, fire apparatus respond from fixed locations (fire stations) rather than from somewhere within the response district, so the ability to predict travel time has value for planning and evaluating fire protection in a community, and for evaluating the ability to deliver needed fire flows using tankers in areas without sufficient fire hydrants.

ISO Evaluation of Travel Time

The ISO Fire Suppression Rating Schedule (FSRS) has always evaluated the distribution of fire resources through the community based on a fixed travel distance of 1.5 miles for an engine company and 2.5 miles for a ladder/service company. In the recently revised ISO FSRS, under Section 510A and 540, as an alternative to the fixed distance used in Section 560, ISO will credit the results of a systematic performance evaluation of travel time using "computer-aided dispatch (CAD) history to demonstrate that, with its current deployment of companies, each fire department meets the time constraints for initial arriving engine in accordance with the general criteria of in NFPA 1710, *Standard for the Organization and Deployment of Fire Suppression Operations, Emergency Medical Operations, and Special Operations to the Public by Career Fire Departments*."

The RAND Institute Travel Time Equation

Over forty years ago, the RAND Institute conducted research on the travel time of various types of fire apparatus. One of the results of this research was the determination that the average speed of a fire engine on an emergency response was 35 miles-per-hour (MPH) over average terrain, with average traffic and weather condition, and slowing for intersections. Another result was the equation commonly referred to as the Rand travel time equation. The equation that is used by ISO and many others is:

$T = 0.65 + 1.7D$

A more accurate way to write the equation is:

$T = 0.65 + KD$

The components of the travel time equation are:

T	travel time in the nearest 1/10 of a minute
0.65	an acceleration constant over the first 2,000 feet of travel
K	defined constant based on the average speed of a given apparatus over a 5 mile course
D	travel distance to nearest 1/10 of a mile

The values for K are shown in the following table. As mentioned above, the RAND studies determined that the average speed for a fire engine was 35 mph, so most people, and ISO, use the K value of 1.7 as a constant.

K Values	
Rate of Speed (mph)	**K value**
60	1.0
55	1.1
50	1.2
45	1.3
40	1.5
35	1.7
30	2.0
25	2.4
20	3.0

NFPA 1710 Travel Time and ISO

NFPA 1710 § 4.1.2.1(3) establishes a travel time of 240 seconds or less for the arrival of the first arriving engine company at a fire suppression incident. Using the equation $T = 0.65 + 1.7D$, where D equals 1.5 miles, ISO determined that the travel time for the first arriving engine is 192 seconds (3.2 minutes). As mentioned above, in Sections 510A and 540 of the FSRS, ISO will consider an alternative to the 1.5 miles travel distance with demonstrated proof that the first company can arrive on the scene within 240 seconds or less travel time on 90% of responses. Using the RAND equation, 240 seconds is equal to about 1.97 miles, a potential 26% improvement in the size of the response district. The key to using the alternative evaluation method for deployment analysis is having accurate data.

Practical Uses of the Equation

However, not all fire apparatus is equal is size, weight, acceleration, response speed, and maneuverability. For example, a tanker may be slower than an engine, and a large ladder truck may be slower than an engine. The RAND studies used the Fire Department of New York as the model for the study, so response territory that is markedly different from an urban city can affect travel time. Still, the K value of 1.7 has proven very reliable over time, but a fire official can use a different K value for his or her community if needed.

To determine the appropriate K value for a community or a specific piece of apparatus, conduct a field study where the apparatus travels a distance of five (5) miles at normal (i.e. non-emergency) driving speeds. Measure how long it takes the apparatus to travel that distance, determine the average speed in miles-per-hour, and refer to the table above and select the appropriate K value.

Fire officials can use the equation when making decision about where to locate, or relocate, a fire station, and to verify response time data from computer aided dispatch (CAD) systems. ISO does not measure or use actual response times of individual communities as most departments lack reliable data, so the fire official can use the equation to verify the accuracy of local data.

Summary

Travel time is an important component of total response time. Travel time can be calculated using a valid equation, and the equation customized for specific apparatus or terrain, and the results used as a planning tool by community leaders. ISO uses the RAND travel time equation when estimating the travel time of fire apparatus. A fire official can use the equation to determine the potential size of the response area for a fire station based upon the ability of the first arriving unit to arrive in 240 seconds or less on 90% of responses. Using the equation is safer and less costly that having fire apparatus respond throughout the community with lights and siren.

References

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Kolesar, P. (1975). *A Model for Predicting Average Fire Company Travel Times*. New York, NY: RAND Institute.

Kolesar, P, & Blum, E. H. (1973). *Square Root Laws for Fire Engine Response Distances*. New York, NY: RAND Institute.

Links:
[1] https://firechief.iso.com/FCWWeb/mitigation/ppc/3000/ppc3015.jsp