

overcome vehicle noise and to provide adequate warning at passive crossings where significant responsibility and discretion is left to the driver. The BLE preferred a variable horn that would allow the engineer to decide when the high horn level was needed.

Because this issue presented complex questions that were not likely to be emphasized in testimony on the extensive NPRM, and because FRA sought to put detailed questions to the railroad industry regarding the horn, FRA held a Technical Conference on Locomotive Horns during the comment period. The conference was attended by railroads, the AAR, locomotive builders General Electric and General Motors, and other industry representatives. In the conference, AAR made FRA aware that the testing procedures set forth in 49 CFR 229.129 were causing a misperception regarding center mounted horns. Because the existing § 229.129 requires measurement of horns 100 feet in front of the locomotive and 4 feet above the rail, it was claimed that an acoustical shadow is cast on the measurement device by the locomotive body when center mounted horns are sounded. This acoustical shadow dissipates quickly as one moves further away or to the side of the locomotive. It was suggested that the testing procedures were giving the impression that center mounted horns were louder to the side than to the front. Conference participants complained that the proposal limiting the horn sound emanating to the side of the locomotive would force them to relocate horns onto the cab from the center of the locomotive, and would increase crew noise exposure. The use of shrouds or shields had been tried by railroads in attendance, and they did not consider them practical. The technical conference also helped FRA understand the railroads' strong commitment to remain using compressed air warning device systems and the many difficulties involved in equipping and maintaining horn systems.

After reviewing the results of the technical conference and comments on the horn provisions, FRA decided to conduct further tests to quantify the effects of horn placement and the influence of variations in available air horn models. A series of stationary tests were performed by the Volpe National Transportation Systems Center (VNTSC) at the Transportation Test Center in Pueblo, Colorado from April 10 to 12, 2001. The results of these tests showed that the shadow effect is very pronounced at the measurement location specified in existing § 229.129. When the traditional cab roof horn

location was compared in these tests with the center of the locomotive body horn location which is current practice, the difference in location produced no meaningful change in community noise exposure nor in the warning signal projected beyond the immediate shadow of the locomotive body. Horns located on the locomotive nose produced less objectionable community noise but also resulted in weaker warning signals and resulted in higher noise levels in the engineer's cab. FRA learned that Transport Canada recently sponsored moving tests of locomotive horns, which showed meaningful differences in the effectiveness of the warning signal provided by horns mounted on the cab roof versus those mounted on the center of the locomotive body. The research indicated that horns mounted at the front of the locomotive on the cab roof produced a more effective warning signal. Because the results of the stationary tests and the technical conference did not justify the provision for a maximum sound limit to the side of the locomotive, it has been eliminated from this interim final rule. However, because the Canadian research indicates that horn location may be a factor in the effectiveness of the warning signal, further research is needed before any regulatory changes are made.

FRA has determined that by changing the measurement procedures in § 229.129, the effect of the shadow can be removed from horn measurement. FRA believes that this simple change, with the additional requirement of remaining below a maximum sound level, will have the effect of normalizing the sound output of all horns. The interim final rule requires that horns be measured at the familiar location, 100 feet in front of the locomotive, however the sound level meter receptor is to be mounted at 15 feet above the rail (*i.e.* out of the locomotive's "shadow").

FRA also continued to review and refine the signal detection theory application previously developed by the FRA Office of Research and Development and reported by the Volpe Center (Railroad Horn Systems Research, USDOT FRA/VNTSC, January 1999) using newly gathered horn measurement data. While lower sound levels would reduce community noise impact, an understanding of the relationship between horn sound level and its detection by motorists is needed to preserve the safety function of the horn. The detectability model was applied to the most critical safety condition at passive crossings where no other audible or visual warning device is present and where vehicles typically

are approaching the crossing at speed. In this case the model suggests that a high likelihood of detection will occur when the horn is producing 108dB(A) at the measurement location, 100 feet in front of the locomotive and at 15 feet in height. FRA added a margin to this level to account for variability in the sound level meters and other factors and set the maximum level at 110dB(A). Although FRA employed the best available tools and knowledge to arrive at this level, additional research may, over time, suggest a different maximum level.

This interim final rule requires railroads to comply with the maximum horn level of 110dB(A) using the new measurement procedures to certify their locomotives. Compliance with the provision is required for new locomotives upon the effective date of this rule which is one year after the date of publication of this rule. Additionally, each existing locomotive shall be tested within five years of this publication date and when rebuilt as determined pursuant to 49 CFR 232.5. FRA also anticipates that whenever repairs or modifications are performed to locomotives that affect the performance of the horn system, the railroad will recertify the locomotive horn to comply with § 229.129.

With the establishment of the maximum sound level for locomotive horns, FRA has also eliminated a plus and minus tolerance in making compliance measurements of horns. FRA anticipates that railroads will set their horns to be somewhat louder than the minimum and quieter than the maximum to account for the minor inaccuracies of the Type II sound level meters currently available. While FRA currently uses Type II sound level meters to test for compliance with part 229.129, FRA may use Type I sound level meters in the future.

Considerable effort has been expended to establish and quantify both the significant risk reduction from regular use of locomotive horns and also the level of sound that needs to be delivered to be detectable. FRA continues to study these issues and may revise these requirements as new information becomes available.

FRA also gave serious consideration to the option of requiring a two-level horn selectable by the locomotive engineer. This approach might allow a lower sound level for actively signed crossings. Historically, horns had been fitted with modulating valves that did provide some latitude for adjustment of the sound level, and communities exposed to today's automatic sequencing horns have expressed