Document Number	Issue Date	Rev. Date
F-2686	06/17/11	

Driveline Torque Rating - Impact of New High Power Engines

New engines meeting the 2010 EPA emission requirements are appearing on the market with high horsepower and torque. How will these new engines affect the driveline components on fire apparatus? Here are some factors to consider.

Waterous Split-Shaft Transmissions

Waterous driveline torque values have been established for the various driveline spline sizes available on Waterous transmissions. The highest rating is 16,000 lb-ft for the 2.35-46T spline used on the current C20 Series transmissions and previously on the C10 and YX Series transmissions. This rating is based on the material properties of the splined shafts and torsional strength testing that was carried out to determine the ultimate strength and fatigue limits at specific cyclical torsion levels. Each cycle subjected the test specimen to a specific torsional load in one rotational direction and then to the same torsional load in the opposite rotational direction. Based on these fatigue tests, the 16,000 lb-ft represents a torque level and number of reversing cycles at the torque level that was judged to safely exceed levels to which fire apparatus are expected to experience.

These fatigue tests can be used to provide insight into the capability of the Waterous driveline should a vehicle experience infrequent driveline torque values that exceed the 16,000 lb-ft level. Considering that the maximum driveline torque would likely occur only if the vehicle became stuck or was attempting to overcome an obstacle such as a curb, the number of times such a situation would occur would likely be small in relation to the number of cycles to which the fatigue tests subjected the driveline components. Contact Waterous for evaluation of specific vehicle configurations.

Other Factors

Other components in the vehicle driveline need to be considered for their torque capabilities.

Automatic Transmission: The automatic transmission transmits engine output torque through the torque converter and then through the gearbox to the transmission output shaft. The torque converter stall capacity and ratio, and the gear ratio through the gearbox will multiply the engine torque and transmit it to the driveline. Allison Transmission publishes a rated torque level for their torque converter output (turbine torque) into the gear set portion of the transmission. Turbine torque levels traditionally have been managed by the selection of torque converter characteristics in relation to the engine characteristics being used for a given application. In the case of the new engines in the market with high output torque, the torque level through the transmission may be maintained by the use of the Allison Engine Management Low Range Torque Protection (LRTP) function. The LRTP interfaces the transmission with the engine to control engine torque output which in turn will limit the resulting driveline torque as the vehicle transitions from standing start to cruising speed. A review of transmission data and ratings provides insight into the maximum driveline torque that driveline components will see in service.

Universal Joints and Drive Shafts: Spicer publishes ratings for commonly used U-joint series. These ratings include continuous torque, short duration and minimum elastic limit. The minimum elastic limit represents the maximum torque load the universal joint will transmit instantaneously without brinelling bearings or yield in any part. This may be assumed to be the maximum safe shock load. Drive shaft designs are commonly driven by the U-joint design and other factors related to speed and length and as a result have similar torsional load capacity.

Smoke-Controlled Engines: In order to reduce emissions, engine management systems may have provisions to control the creation of excessive smoke and this may affect driveline torque at low vehicle speeds. At low engine speeds, the turbocharger boost and the volume of air flow are diminished and the fuel delivery is reduced to avoid the creation of excessive exhaust smoke. Until the turbocharge boost is able to increase the intake air flow as the engine speed increases from idle, the engine power and torque are reduced from the commonly published full throttle “lug back” engine curve. Depending on the selection of torque converter and its stall speed, the driveline torque at low vehicle speeds may be significantly less that the “theoretical” calculations based on the engine curve.

Conclusion: New engines with increased power and torque are now available. Apparatus manufacturers need to consider the total driveline system and not just individual components when designing vehicles using these new engines.