



## San Diego Off Road Innovations LLC

### Vehicle Alteration Document

**Product:** Toyota 4wd Ball Joint Spacers

**Abstract:** This document describes the operational impacts of the SDORI ball joint spacer lift kit as well as the engineering and manufacturing practices used to design and manufacture the spacers.

**Applications:** The SDORI 4wd spacers fits US model four wheel drive Toyota pickups and 4runners from 1986 to 1995 and foreign models utilizing the same suspension.

**Theory of operation:** These trucks use an independent front suspension (IFS) where a torsion bar spring is fastened to the upper control arm (UCA). The spacer is placed between the upper ball joint and upper control arm. This has the effect of increasing the suspension window of travel 1.5". The amount of lift varies and is adjusted by the user. By adjusting the torsion bars the suspension can be set anywhere within the travel window.

**Impacts on highway use:** Since the vehicle now has more suspension travel, customers report an improvement in drive quality. For example, when the vehicle encounters a "pothole" or depression in the road, the wheel can travel down into and out of the depression maintaining better contact with the road. This lessens the feeling the truck is falling into deep depressions. The result of the front wheels remaining in more solid contact with the road during harsh bumps improves control and passenger comfort. SDORI ball joint spacers are therefore deemed suitable for highway and off road use.

**Design and construction:** The spacers were designed and engineered using modern computer aided design (CAD) methods. The suspension geometry was analyzed to find the limits of travel. The spacer was designed based on the ball joint mounting constraints in Solidworks. Materials were analyzed using finite element analysis (FEA) in Cosmosworks and a final material and design was selected. Each spacer is made from 6061 T6 aircraft grade aluminum on computerized numerically controlled (CNC) milling machinery. Under FEA, one spacer was able to hold over 112,000kg (300,000lb). Exact geometric dimensioning and tolerance data is proprietary to SDORI.

**Impacts on durability:** The spacer itself is many times stronger than necessary. The hardware used is metric automotive quality and consists of the following:

(8) class 12.9 capscrews

(8) class 10.9 nuts

(8) class 8.8 nylock nuts (used only to prevent loosening and keep moisture out of the threads to ease disassembly in the future)

(16) Flat washers are used on both fastening surfaces to diffuse load.

Therefore, SDORI, sees no decrease in durability of the vehicle suspension or decrease in load bearing capacity. In fact, the added suspension travel improves the suspension's ability to absorb impact.

For questions or other information, please contact SDORI at [sales@sdori.com](mailto:sales@sdori.com).

Regards,



Frank J Falcone III  
Co-owner and Engineer  
San Diego Off Road Innovations LLC  
2310 South 2<sup>nd</sup> St.  
Austin, Tx 78704, USA