POWERS & SONS

BENCHMARKING REVIEW

REASONS FOR BENCHMARKING

- Design features/Innovations-thought starters
- New Processes/materials-skinning cats
- Differing Standards - Honda thread depth
- Design Cost / manufacturing efficiencies
- Design elements to be avoided- learn from other peoples mistakes
- What's different and why? - grain of salt
- Functional comparison - BIC characteristics

Lessons Learned from Benchmarking

- P&S has least end motion LFL ball joint.
- GM has virtually common rod ends across carlines
- Moly/lithium is the most commonly used lubricant
- Top closure - manufacturing economies
- Spin closure is most common in ball joints
- Variations in jam nut design
- Movement away from cotter pin ball studs
- Variations in ball stud and forging coatings

Selection Process

- Trade Journals/Enthusiast Magazines
- Word of Mouth
- Common Vendors
- Auto Shows / Dealer Reviews
- Campaign announcements
- Tracking aftermarket
- Customer Input

Ball Joint Forensics

- Breakaway, rotation, articulation torques
- End motion
- Standard Wear Test Inconclusive
- Disassembly
  - ball studs
  - bearings
  - housings
  - lubricants
  - seals

Benchmark Part Sources

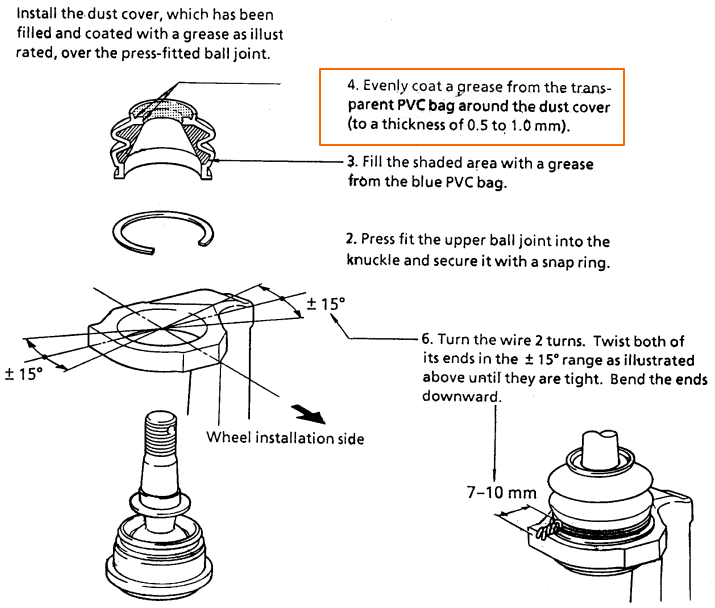
- OE Dealers
  - Additional Processing Information
  - Additional Assembly Information

2000 Toyota Tundra

Assembly Procedure

Repair the assembly using the parts supplied.

1. Remove a damaged ball joint.
Caution: Do not reuse any parts removed.
2. Referring to the service manual, press fit a new ball joint into the knuckle and secure it with a snap ring.
3. Evenly fill a new dust cover with a grease from the blue PVC bag supplied.
4. Evenly apply a grease from the transparent PVC bag supplied around the lip of a new dust cover (to a thickness of 0.5 to 1.0 mm).
5. Install the dust cover over the ball joint which has been press fitted into the knuckle and secured with the snap ring.
Note: Wipe off grease from the ball stud thread and tapered surface.
6. Straighten the wire supplied, wind it around the dust cover along the groove 2 turns, and twist both of its ends together until they are tight.
Notes:
1) Make sure that the twisted ends of the wire are positioned in the ± 15° range as illustrated
2) Cut the twisted length to 7 to 10 mm and bend the ends downward.
3) Make sure that the wire does not move in either way under a slight turning force applied to the twisted ends by fingers.
7. Do not install the repaired assembly in the vehicle until it is ensured that the ball stud thread and tapered surface are clean of grease.



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Benchmark Part Sources

- OE Dealers
- Wrecking Yards
  - High Mileage examples
  - True OE application
- Employee Vehicles
  - Known History
- Customer Vehicle Benchmarking
  - Competitive Durability
  - AEMS 150,000 mile fleet

Case History

- The following example shows multiple uses of benchmarking
- VW Passat tie rod end was originally added to library because of aluminum housing and rubber isolator

VW Passat/Audi A4 Tie Rod End

Aluminum Housing

Rubber Isolator

Recall Data Analysis

- 6 months after Powers & Sons acquired Passat tie rod end for benchmarking, NHTSA issued Recall notice

Office of Defects Investigation
Recall Database

Call the **Auto Safety Hotline** toll free at (888) 327-4236 to report safety defects or to obtain information on cars, trucks, child seats, highway or traffic safety.

Report Date: July 6, 2000 02:54:03 PM

NHTSA CAMPAIGN ID Number: 99V248000

Component: STEERING:LINKAGES:ROD:RELAY:CONNECTING
Manufacturer: VOLKSWAGEN OF AMERICA,INC
Mfg. Campaign #: KW
Year: 1998
Make: AUDI
Model: A4
Potential Number of Units Affected: 51900
Manufactured From: JAN 1998 To: JUL 1998
Year of Recall: '99
Type of Report: Vehicle
Summary:

Vehicle Description: Passenger vehicles. The tie rods of the steering assembly are protected on each side by a seal to prevent moisture and dust particles from entering the swivel bearing mechanism. It is possible that some tie rod seals may not seal properly.

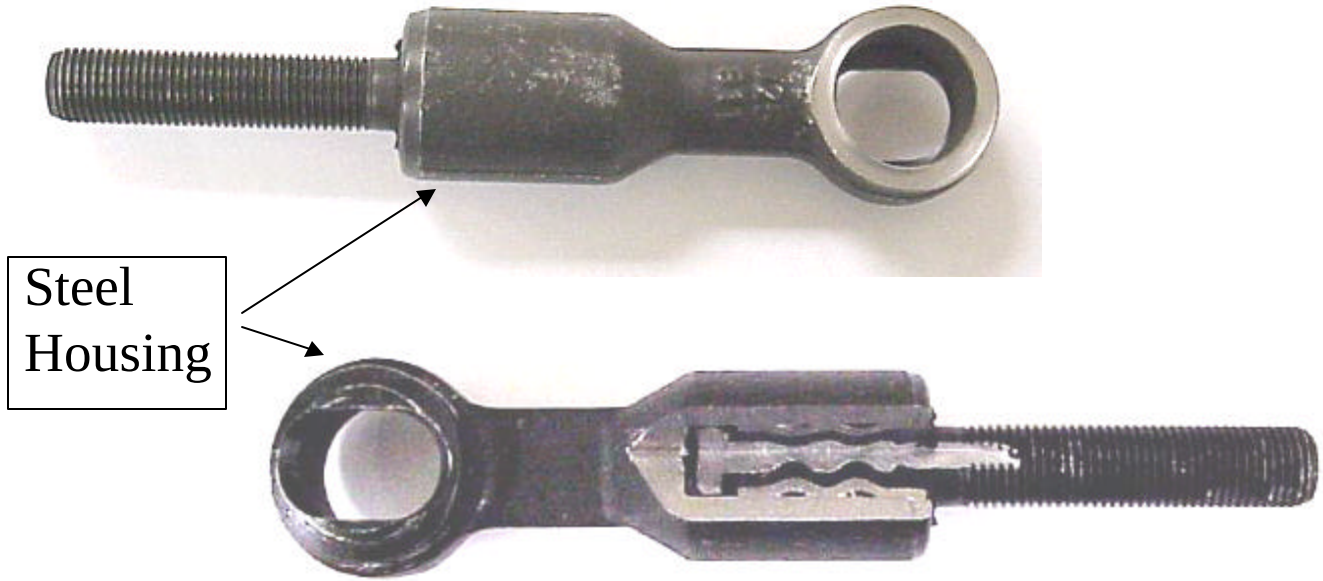
If moisture and/or dust particles enter the swivel bearing mechanism, the swivel bearing could wear over time diminishing the steering control of the vehicle.

Dealers will replace the tie rods. Owner notification began October 5, 1999. Owners who take their vehicles to an authorized dealer on an agreed upon service date and do not receive the free remedy within a reasonable time should contact Volkswagen at 1-800-822-8987 or Audi at 1-800-822-2834. Also contact the National Highway Traffic Safety Administration's Auto Safety Hotline at 1-888-DASH-2-DOT (1-888-327-4236).

Recall Parts Analysis

- Back to dealer for more parts for analysis
- These parts were different from original parts

Service Passat Outer End



Engineering Analysis

- Why Change housing from Aluminum to Steel?
  - Lower material cost?
  - Higher pull out strength if seal fails and joint wears out?

Many Months Later

Domestic OE Steering Nibble

- Current OE vehicle has steering nibble with steel wheels - Aluminum wheels on base car - $125/veh penalty
- Customer Development Engineer asked P&S about RBS
- Powers & Sons used the Benchmark library RBS part to explain issues with RBS

Rubberized Ball Socket (RBS)

Benchmarking Light bulb

- Customer wanted RBS to eliminate brake shudder
- Problem history with RBS
- Customer ***really*** wanted isolating tie rod
- showed Passat part
- provided 2 parts for cut/weld evaluation