

Development of Transfer Gear Noise of 4X4 Transmission for Recreational Vehicles

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TECHNICAL PAPER

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[The statements and opinions contained herein are those of the author and should not be construed as an official action or opinion of the American Gear Manufacturers Association.]

ABSTRACT:

In our Component Plant, we have been producing about 120,000 MUA 4×4 transmission per year for our recreational vehicles since 1987.

Transfer gear noise of MUA 4×4 units have been one of the most severest customers' claims, especially in the end of 1991.

We have developed new methods to reduce transfer gear noise, which consist of gear development making use of tooth contact patterns, a new regrinding system for shaving cutters, quality control by the Gear Laboratory Group, improvement activities for gear production processes and so on.

By these developments extending for one year, we have succeeded in reducing the reject rate from 4.5% to 0.5%, moreover improving the transfer gear noise rating from 4.0 – 6.0 to 8.0 – 10.0 by GM rating (table 1) in 1993.

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DEVELOPMENT OF TRANSFER GEAR NOISE OF A 4 × 4 TRANSMISSION FOR RECREATIONAL VEHICLES

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1. INTRODUCTION

MUA 4 × 4 transmissions have been produced since 1987. Annual production volume of the transmissions varies from 100,000 to 120,000; so that accumulated products have become 700,000 approximately.

The part of the transfer gear box is almost the same for both of the automatic transmissions and manual ones.

Concerning four wheel drive automobiles, customers tend to complain about transfer gear noise in four wheel driving. Gear noise in two wheel driving is not so critical for the customers.

Incidentally the transmissions are not only installed in the domestic recreational vehicles, but also have been shipped to a final assembly plant in Great Britain as vehicle components since 1991 with the volume of 24 thousand units per year.

In Nov.'91, a number of MUA units had been rejected in Great Britain because of unacceptable transfer gear noise with GM rating 3 - 4. (Table 1)

Same kinds of claims had been reported in Japan and in the U.S.A. also.

Therefore we have started respective improvement activities shown below since Mar.'92.

- ① Gear development - Study of the ideal involute helicoid for gear noise reduction
- ② Improvement of shaving process
 - Shaving cutter regrinding system
 - Quality control system for shaving
- ③ Establishment of quality control system for gear precision
 - Gear distortion study by carburizing
 - Periodical precision check for gear checkers
 - Gear data stock system
 - Change of production process orders

④ Gear noise judgement system

- 100% check in mass production
- Evaluation by noise analyzing devices as well as inspectors' sensual feeling

By these methods, transfer gear noise had been much improved, and has been maintained in good level since Mar.'93; so that we'd like to describe the contents hereafter.

10	NOT NOTICEABLE EVEN BY TRAINED EVALUATORS	COMMERCIAL	10	EXCELLENT	COMMERCIAL
9	NOTICEABLE ONLY BY TRAINED EVALUATORS		9	VERY GOOD	
8	NOTICEABLE ONLY BY CRITICAL CUSTOMERS		8	GOOD	
7	NOTICEABLE BY ALL CUSTOMERS		7	SATISFACTORY	
6	RATED DISTURBING BY SOME CUSTOMERS		6	AGREEABLE	
5	RATED DISTURBING BY ALL CUSTOMERS	NON-COMMERCIAL	5	MEDIOCRE	NON-COMMERCIAL
BORDERLINE			BORDERLINE		
4	RATED AS FAILURE BY ALL CUSTOMERS		4	POOR	
3	COMPLAINED AS BAD FAILURE BY ALL CUSTOMER		3	VERY POOR	
2	LIMITED OPERATION		2	BAD	
1	NON OPERATIONAL		1	VERY BAD	

Table 1 Subjective GM gear noise rating