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United States General Accounting Office

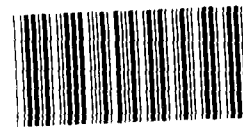
GAO

Report to the Chairman,
Subcommittee on Oversight and
Investigations, Committee on Energy and
Commerce, House of Representatives

May 1988

BRADLEY VEHICLE

Status of Transmission's Reliability



135817

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**National Security and
International Affairs Division**

B-221733

May 4, 1988

The Honorable John D. Dingell
Chairman, Subcommittee on Oversight
and Investigations
Committee on Energy and Commerce
House of Representatives

Dear Mr. Chairman:

In accordance with your request of September 30, 1987, and subsequent agreements with your staff, the following information is being provided in response to questions concerning (1) the Bradley Fighting Vehicle transmission's reliability problems, (2) the performance of the modified transmission (which began to be fielded in November 1985) to correct these problems, and (3) the cost of the modifications and who paid for them.

The only reliability requirement in the system specification for the Bradley was that the vehicle achieve 240 mean miles between combat mission failures. This requirement was achieved during initial production testing completed in August 1983. The components of the Bradley (including the transmission) did not have to meet reliability requirements. During development testing, the transmission achieved 14,000 mean miles between failures, which decreased to about 5,500 mean miles between failures in initial production testing.


Since early 1983, the transmission has undergone numerous quality and design modifications to improve reliability—the most current scheduled to be completed in September 1988. The Army accepted the transmission's design and therefore paid for design-related modifications. Data provided to us showed that modifications related to inadequate quality control during manufacturing (replacement of defective parts or components) were to be made at no cost to the Army. Although early results from the field indicate an improvement in reliability, additional field experience with the modified transmission is necessary to determine its current reliability. More detailed responses to your questions are in appendix I.

In conducting our work, we visited the U.S. Army Tank and Automotive Command, General Electric (the transmission's manufacturer), and FMC (the Bradley's prime contractor). At each of these locations, we interviewed engineers and management personnel about the transmission

problems. We reviewed available records on testing dating back to 1975. We also examined records and data supporting major reliability modifications made to the transmission. We did not examine the underlying support for the costs of the modifications. Our work was accomplished during January and February 1988. As requested, we did not obtain agency comments.

As arranged with your office, unless you publicly announce its contents earlier, we plan no further distribution of this report until 7 days from the date of the report. At that time we will send copies to interested parties and make copies available to others upon request. Should you need further information, please contact me at 275-4133.

Sincerely yours,



Mark E. Gebicke
Associate Director

Responses to Questions Concerning the Bradley Fighting Vehicle's Transmission

The following is information we obtained in response to specific questions raised by your staff.

1. Why did the Army accept the transmission when it was having so many problems?

The production decision for the Bradley was made in February 1980. At that time, developmental and operational testing was nearly completed. Results of these tests showed that the Bradley had exceeded its system reliability requirement of 195 mean miles between combat mission failures (this requirement was increased to 240 miles for initial production testing). The components of the Bradley (including the transmission) did not have to meet specific reliability requirements. We noted, however, that there were no major deficiencies found in the transmission during developmental and operational testing. When the system requirement was met and the vehicle accepted, all components were also accepted.

The transmission experienced a significant decrease in reliability—dropping from about 14,000 mean miles between failures in developmental testing to about 5,500 mean miles between failures in production testing. However, the system reliability requirement was achieved despite the increase in transmission failures.

2. How long has the Army known, or for how long should it have known, that the transmission was a problem? Did preproduction test results indicate serious problems?

Major problems with the transmission began to surface in the Initial Production Test, which was completed in August 1983. Problems also surfaced on some of the first fielded vehicles beginning in the summer of 1983. By this time, the system was in the third year of production.

Some of the reasons cited by U.S. Army Tank and Automotive Command, General Electric, and FMC personnel for the transmission problems encountered when the Bradley moved from development to production were as follows:

- Development tests used prototype transmissions, which had in effect been hand-built using parts and components furnished by vendors. Most of the vendors lacked sufficient capacity to meet higher production volumes, and new suppliers had to be identified. This resulted in a decrease in the production quality of components produced by many of

- the new suppliers. In addition, General Electric lacked an adequate quality control system to detect defective parts coming from its suppliers.
- The Bradley experienced design problems in moving from development to production. The differences between hand-built and mass-produced transmission components had to be resolved. In addition, design tolerances had to be refined based on production tests and field results.
 - Although the Army had attempted to create real-life situations in the Bradley's test environments, transmission problems occurred in the field that could not be detected in the tests.

Officials from the Army, General Electric, and FMC all agreed that General Electric's quality control system was a major problem. Consequently, actions such as increasing the number of quality inspectors, initiating quality audits, and improving training were taken to improve quality control.

General Electric believes that, with improved quality control along with producibility design changes and modifications made to address test and field problems, it is now producing a reliable transmission. In its view, the transmissions produced before these design changes were the ones with reliability problems, and now that the transmissions have been modified, reliability should improve.

3. What is the cost of the modifications being made, and who is paying for them?

Two types of modifications have been made to the transmission: (1) design-related modifications to improve reliability and (2) quality-related modifications to replace defective parts or components. Design modifications were made to the design accepted by the Army and therefore were paid for by the Army. Data provided to us by General Electric showed that quality modifications, on the other hand, were made by General Electric at no cost to the Army.

Twelve major field modifications have been made to the Bradley transmission to improve its reliability. These modifications and associated costs are discussed below.

- Seven of the modifications, referred to as the "Big 6" plus a modified dipstick, were completed in 1986. The hardware cost for the modifications, paid for by the Army, is estimated at \$437,345. FMC was unable to estimate the labor costs applicable to these modifications.

- In 1986, the Army initiated a product improvement program to install into fielded vehicles a second group of modifications to improve the transmission's reliability. These installations are scheduled to be completed in September 1988. These reliability modifications are referred to as the "Big 5." The estimated cost for these five modifications was \$2.466 million. Of this total, \$898,000 was for hardware, and \$1,568 million was for labor.

In addition to design modifications, General Electric replaced a number of parts or components in transmissions of fielded systems with defects attributable to deficiencies in quality control processes. These field repairs and replacements, according to General Electric and FMC representatives, were done at no cost to the Army. In validating this information, we identified eight such modifications to correct or replace defective parts in the field. The engineering change proposals under which these modifications were processed all indicated that they were to be done at no cost to the Army.

4. What are the contract specifications for the transmission? Are any of the defects latent? (Should the contractor be held responsible?)

The product specification for the transmission establishes the performance, design, and test requirements. The specification represents a comprehensive explanation of required transmission performance and covers such things as physical characteristics, performance, and durability. The specifications do not have a reliability requirement. A product specification component test was completed in March 1982, and the transmission passed.

A latent defect related to quality is one that would not be found in normal acceptance testing. Tank and Automotive Command officials acknowledged that these defects, when found, should be corrected at no cost to the Army. The eight quality modifications replacing defective parts mentioned earlier are examples of latent defects, which available documents indicated were corrected at no cost to the Army.

5. To the extent data is available, how are the modified transmissions performing?

We were informed that modifications of fielded transmissions with the "Big 6" were completed in early 1986 and that completion of the "Big 5" modifications is scheduled for September 1988. While only limited miles

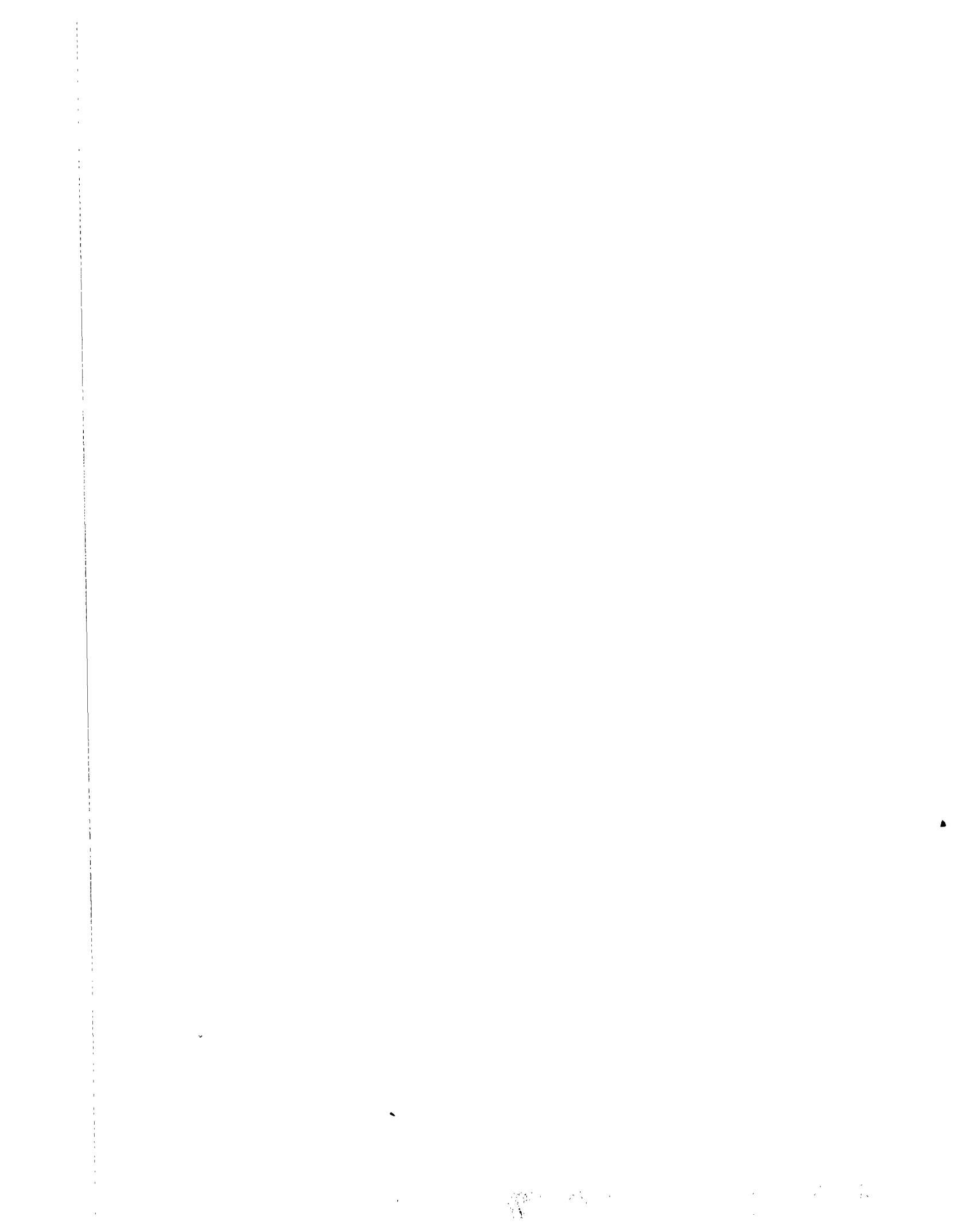
have been put on the completely modified transmissions, preliminary data does indicate an improvement in reliability.

For example, transmission reliability experienced by U.S. combat units in exercises held in Germany prior to the "Big 6" modifications was less than 3,000 mean miles between replacement. Reliability, after the "Big 6" modifications were added, increased to over 9,000 mean miles between replacement and again increased to over 12,000 mean miles after the "Big 5" modifications were added. As the modified transmissions accumulate additional miles, more meaningful data will be available for determining reliability improvements.

6. What is the status of the new transmission being designed for the high survivability vehicle?

The Army has decided to incorporate a number of survivability enhancements into Bradley production and to install these improvements in most of the fielded Bradleys. To compensate for the weight increase that will result (an increase from 50,450 to 66,000 pounds), the Army also plans to replace the current 500-horsepower engine with a 600-horsepower engine. To keep pace with the additional weight and added horsepower, General Electric is developing an upgraded version of the existing transmission.

According to a General Electric official, the new transmission is currently undergoing first article testing, which is scheduled to be completed by September 1988. The current schedule calls for the new transmission to be fielded in May 1989. On the Bradleys being used in the engineering development tests, this transmission has accumulated a limited number of miles, and as of February 1988 no transmission incidents had been reported.



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