474

AIR FORCE A–7D BRAKE PROBLEM

#474

HEARING

BEFORE THE

SUBCOMMITTEE ON ECONOMY IN GOVERNMENT

OF THE

JOINT ECONOMIC COMMITTEE
CONGRESS OF THE UNITED STATES

NINETY-FIRST CONGRESS

FIRST SESSION

AUGUST 13, 1969

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AIR FORCE A-7D BRAKE PROBLEM

WEDNESDAY, AUGUST 13, 1969

CONGRESS OF THE UNITED STATES,
SUBCOMMITTEE ON ECONOMY IN GOVERNMENT
OF THE JOINT ECONOMIC COMMITTEE,
Washington, D.C.

The Subcommittee on Economy in Government met, pursuant to notice, at 9:30 a.m., in room G-308 (auditorium), New Senate Office Building, Hon. William Proxmire (chairman of the subcommittee) presiding.

Present: Senator Proxmire and Representative Conable.

Also present: Richard F. Kaufman, economist; and Douglas C. Frechtling, economist for the minority.

Chairman PROXMIRE. The subcommittee will come to order.

Our first witnesses this morning are Mr. Kermit Vandivier and Mr. Searle Lawson. Both gentlemen I understand are former employees of the Goodrich Co., and these are the gentlemen who initially provided information on which I made a statement about a Goodrich four-rotor brake on the floor of the Senate.

I thought it best to have Mr. Vandivier and Mr. Lawson appear and state to the committee the situation as they see it.

I understand, Mr. Vandivier, you have a prepared statement. You can handle it any way you wish. We have four other groups of witnesses scheduled to appear. This is the first group to appear this morning. We hope that we can limit this hearing to this one session and to give everybody an opportunity to speak.

You may begin now and then we will ask questions.

STATEMENTS OF KERMIT VANDIVIER, THE TROY DAILY NEWS, AND SEARLE LAWSON, DALLAS, TEX.

Mr. VANDIVIER. Thank you, Mr. Chairman.

Chairman PROXMIRE. Could I ask first, it has been suggested by the staff, I think it would be helpful, because of the nature of this inquiry, if you would give us a brief statement as to your background.

Mr. VANDIVIER. I am 42 years old. I am a high school graduate. I worked for the Goodrich Co. for approximately 6 years. I am now employed as the staff writer for the Troy Daily News.

Chairman PROXMIRE. All right, sir.

And Mr. Lawson, will you give us your background?

Mr. LAWSON. Yes, sir. I am 28 years old and I am a college graduate and have a degree in aeronautical and astronautical engineering and a certificate in aircraft design technology. I am presently employed at LTV Aerospace Corp.

Chairman PROXMIRE. Ling-Temco-Vought?

Mr. Lawson. Yes.

Chairman Proxmire. Thank you.

Mr. Vandivier. In the early part of 1967, the B. F. Goodrich Wheel & Brake Plant at Troy, Ohio, received an order from the Ling-Temco-Vought Co. of Dallas, Tex., to supply wheels and brakes for the A-7D aircraft, built by LTV for the Air Force.

The tests on the wheels and brakes were to be conducted in accordance with the requirements of military specification Mil-W-5013G as prepared and issued by the U.S. Air Force and to the requirements set forth by LTV Specification Document 204-16-37D.

The wheels were successfully tested to the specified requirements, but the brake, manufactured by Goodrich under BEG part No. 2-1162-3, was unable to meet the required tests.

The laboratory tests specified for the brake were divided into two categories: dynamic brake tests and static brake tests.

The dynamic brake tests basically consisted of 45 stimulated normal energy stops, 5 overload energy stops and one worn-brake maximum energy stop, sometimes called a rejected take-off, or RTO.

These simulated stops were to be conducted on one brake assembly with no change in brake lining to be allowed during the test.

In addition, a maximum energy brake stop (or RTO) was to be conducted on a brake containing new linings and still another series of tests called a turnaround capability test was to be performed.

The turnaround capability test consisted of a series of taxis, simulated takeoffs, flight periods and landings, and time schedule for the turnaround test was supplied by LTV to coincide with conditions under which the A-7D brake might operate on a typical mission.

Generally speaking, the brake successfully passed all the static brakes tests, but the brake could not and did not pass any of the dynamic tests I have just described with the exception of the new brake maximum energy stop.

During the first few attempts to qualify the brake to the dynamic tests, the brake ran out of lining material after a few stops had been completed and the tests were terminated. Attempts were made to secure a lining material that would hold up during the grueling 51-stop test, but to no avail.

Although I had been aware for several months that great difficulty was being experienced with the A-7D brake, it was not until April 11, 1968, almost a full year after qualification testing had begun, that I became aware of how these tests were being conducted.

The 13th attempt at qualification was being conducted under B. F. Goodrich Internal Test No. T-1867.

On the morning of April 11, Richard Gloor, who was the test engineer assigned to the A-7D project, came to me and told me he had discovered that some time during the previous 24 hours, instrumentation used to record brake pressure had *deliberately* been miscalibrated so that while the instrumentation showed that a pressure of 1,000 pounds per square inch had been used to conduct brake stops No. 46 and 47 (two overload energy stops) 1,100 p.s.i. had actually been applied to the brakes. Maximum pressure available on the A-7D is 1,000 p.s.i.

Mr. Gloor further told me he had questioned instrumentation personnel about the miscalibration and had been told they were asked to do so by Searle Lawson, a design engineer on the A-7D.

Chairman PROXMIRE. Is this the gentleman who is with you now, Mr. Vandivier?

Mr. VANDIVIER. That is correct. I subsequently questioned Lawson who admitted he had ordered the instruments miscalibrated at the direction of a superior.

Upon examining the log sheets kept by laboratory personnel I found that other violations of the test specifications had occurred.

For example, after some of the overload stops, the brake had been disassembled and the three stators or stationary members of the brake had been taken to the plant toolroom for rework and during an earlier part of the test, the position of elements within the brake had been reversed in order to more evenly distribute the lining wear.

Additionally, instead of braking the dynamometer to a complete stop as required by military specifications, pressure was released when the wheel and brake speed had decelerated to 10 miles per hour.

The reason for this, I was later told, was that the brakes were experiencing severe vibrations near the end of the stops, causing excessive lining wear and general deterioration of the brake.

All of these incidents were in clear violation of military specifications and general industry practice.

I reported these violations to the test lab supervisor, Mr. Ralph Gretzinger, who reprimanded instrumentation personnel and stated that under no circumstance would intentional miscalibration of instruments be tolerated.

As for the other discrepancies noted in test procedures, he said he was aware they were happening but that as far as he was concerned the tests could not, in view of the way they were being conducted, be classified as qualification tests.

Later that same day, the worn-brake, maximum energy stop was conducted on the brake. The brake was landed at a speed of 161 m.p.h. and the pressure was applied. The dynamometer rolled a distance 16,800 *feet* before coming to rest. The elapsed stopping *time was 141 seconds*. By computation, this stop time shows the aircraft would have traveled over 3 miles before stopping.

Within a few days, a typewritten copy of the test logs of test T–1867 was sent to LTV in order to assure LTV that a qualified brake was almost ready for delivery.

Virtually every entry in this so-called copy of the test logs was drastically altered. As an example, the stop time for the worn brake maximum energy stop was changed from 141 seconds to a mere 46.8 seconds.

On May 2, 1968 the 14th attempt to qualify the brakes was begun, and Mr. Lawson told me that he had been informed by both Mr. Robert Sink, project manager at Goodrich—I am sorry, Mr. Sink is project manager—and Mr. Russell Van Horn, projects manager at Goodrich, that "Regardless of what the brake does on test, we're going to qualify it."

Chairman PROXMIRE. What was that?

Mr. VANDIVIER. The statement was, "Regardless of what the brake does on test, we're going to qualify it."

He also said that the latest instructions he had received were to the effect that if the data from this latest test turned out worse than did test T–1867, then we would write our report based on T–1867.

Chairman PROXMIRE. The statement was made by whom?

Mr. VANDIVIER. Mr. Lawson told me this statement was made to him by Mr. Robert Sink, projects manager and Mr. Russell Van Horn, project manager.

During this latest and final attempt to qualify the four rotor brake, the same illegal procedures were used as had been used on attempt No. 13. Again after 30 stops had been completed, the positions of the friction members of the brake were reversed in order to more evenly distribute wear.

After each stop, the wheel was removed from the brake and the accumulated dust was blown out.

During each stop, pressure was released when the deceleration had reached 10 miles per hour.

By these and other irregular procedures the brake was nursed along until the 45 normal energy stops had been completed but by this time the friction surfaces of the brakes were almost bare, that is, there was virtually no lining left on the brake.

This lack of lining material introduced another problem.

The pistons which actuate the brake by forcing the friction surfaces together were almost at the end of their allowable travel and it was feared that during the overload stops the pistons might actually pop out of their sockets within the brake, allowing brake fluid to spray the hot surfaces, resulting in fire.

Therefore, a metal spacer was inserted in the brake between the pressure plate and the piston housing.

This spacer served to make up for the lack of friction material and to keep the pistons in place.

In order to provide room for the spacer, the adjuster assemblies were removed from the brake.

The five overload stops were conducted without the adjuster assemblies and with the spacer in place.

After stop number 48—the third overload stop—temperatures in the brake were so high that the fuse plug, a safety device which allows air to escape from the tire to prevent blowout, melted and allowed the tire to deflate.

The same thing happened after stop number 49—the fourth overload stop. Both of these occurrences were highly irregular and in direct conflict with the performance criteria of the military requirements.

Chairman PROXMIRE. I understand you have a picture of this that might help us see it.

Mr. VANDIVIER. Yes.

Mr. PROXMIRE. Do you want to show that to us now?

Mr. VANDIVIER. I was going to show it here just a little bit later.

Chairman PROXMIRE. Go ahead.

Mr. VANDIVIER. For the worn brake maximum energy stop the adjusters were replaced in the brake and a different spacer was used between the pressure plate and the piston housing.

Now I have a copy, a picture of this brake just before it went on the maximum energy test, and here you may see at the top is the additional spacer that has been added in order to get sufficient braking action on the brake.

Chairman PROXMIRE. Who took that picture?

Mr. VANDIVIER. That was taken with a Polaroid camera. I am not sure——

Chairman PROXMIRE. I think it is only fair to the committee, Mr. Conable and the committee, to ask you about it later. You go ahead and we will ask questions.

Mr. VANDIVIER. All right.

In addition to these highly questionable practices, a turnaround capability test, or simulated mission test, was conducted incorrectly due to a human error. When the error was later discovered, no corrections were made.

While these tests were being conducted, I was asked by Mr. Lawson to begin writing a qualification report for the brake. I flatly refused and told Mr. Gretzinger, the lab supervisor, who was my superior, that I could not write such a report because the brake had not been qualified.

He agreed and he said that no one in the laboratory was going to issue such a report unless a brake was actually qualified in accordance with the specification and using standard operating procedures.

He said that he would speak to his own supervisor, the manager of the technical services section, Mr. Russell Line, and get the matter settled at once.

He consulted Mr. Line and assured me that both had concurred in the decision not to write a qualification report.

I explained to Lawson that I had been told not to write the report, and that the only way such a report could be written was to falsify test data.

Mr. Lawson said he was well aware of what was required, but that he had been ordered to get a report written, regardless of how or what had to be done.

He stated if I would not write the report he would have to, and he asked if I would help him gather the test data and draw up the various engineering curves and graphic displays which are normally included in a report.

I asked Mr. Gretzinger, my superior, if this was all right and he agreed as long as I was only assisting in the preparation of the data, it would be permissible.

Both Lawson and I worked on the elaborate curves and logs in the report for nearly a month. During this time we both frankly discussed the moral aspects of what we were doing and we agreed that our actions were unethical and probably illegal.

Several times during that month I discussed the A7D testing with Mr. Line, and asked him to consult his superiors in Akron, in order to prevent a false qualification report from being issued.

Mr. Line declined to do so and advised me that it would be wise to just do my work and keep quiet.

I told him of the extensive irregularities during testing and suggested that the brake was actually dangerous and if allowed to be installed on an aircraft, might cause an accident.

Mr. Line said he thought I was worrying too much about things which did not really concern me and advised me to just "do what you're told."

About the first of June——

Chairman PROXMIRE. You skipped one line here.

Mr. VANDIVIER. Yes.

Chairman PROXMIRE. You said "I asked him"——

Mr. VANDIVIER. Yes. I asked Mr. Line if his conscience would hurt him if such a thing caused the death of a pilot and this is when he replied I was worrying about too many things that did not concern me and advised me to "do what you're told."

About the first of June 1968, Mr. Gretzinger asked if I were finished with the graphic data and said he had been advised by the chief engineer, Mr. H. C. Sunderman, that when the data was finished it was to be delivered to him—Sunderman—and he would instruct someone in the engineering department to actually write the report.

Accordingly, when I had finished with the data, I gave it to Mr. Gretzinger who immediately took it from the room. Within a few minutes, he was back and was obviously angry.

He said that Mr. Sunderman had told him no one in the engineering department had time to write the report and that we would have to do it ourselves.

At this point Mr. Line came into the room demanding to know "What the hell is going on." Mr. Gretzinger explained the situation again and said he would not allow such a report to be issued by the lab.

Mr. Line then turned to me and said he was "sick of hearing about this damned report. Write the ——— thing and shut up about it."

Chairman PROXMIRE. Let me ask you, you had this in quotes. Did you make a note of this at the time?

Mr. VANDIVIER. Yes.

Chairman PROXMIRE. Do you have your notes with you?

Mr. VANDIVIER. No. I have notes with me, yes. I am not sure if I have this note or not, but I have notes with me.

Chairman PROXMIRE. All right.

Mr. VANDIVIER. When he had left, Mr. Gretzinger and I discussed the position we were in and Mr. Gretzinger said that we both should have resigned a long time ago. He added that there was little to do now except write the report.

Accordingly, I wrote the report, but in the conclusion, I stated that the brake had "not" met either the intent or the requirements of the specifications and was therefore "not" qualified.

When the final report was typewritten and ready for publication, the two "nots" in the conclusion and been eliminated, thereby changing the entire meaning of the conclusion.

I would like to point out at this time the various discrepancies between the military standards and procedures and the qualification tests actually conducted:

1. Brake pressure was cut on all stops at 10 miles per hour and the wheel allowed to coast to a stop.
2. The five overload stops were conducted with a spacer between the pressure plate and the piston housing.
3. The lining carriers used for the test were specially made with an additional 0.030 of an inch lining material. This was done to assure sufficient lining material on the carriers.
4. Stators in the brake were physically reversed after stop 30 and remained in those positions throughout the test.

Mr. Chairman, the next two sentences of my printed statement contain a typographical error, words have been omitted and I would like to insert those in at this time.

5. The worn brake RTO was conducted with an additional pressure plate between the original pressure plate and piston housing. This was done because allowable piston travel had been exceeded and without the additional pressure plate the brakes could not have been applied.

6. Prior to the worn brake RTO (maximum energy stop), the inside diameter of the lining carriers was increased by 0.120 of an inch to alleviate the severe shrinkage of the lining carriers on the torque tube caused by overheating.

7. On stops 48 and 49 (overload stops 3 and 4) the fuse plug eutectic material—material designed to melt at a specified temperature—melted, allowing the tire to deflate.

8. The torque plate and keyway inserts for the wheel had their drive surfaces chromeplated, because of extreme wear. This was not a production process on this brake.

9. Before the start of the tests and at teardowns the keyway inserts were sprayed with molybdenum disulfate (a lubricant).

10. After every stop the wheel and tire assembly were removed from the brake, the brake was blown out with high-velocity air and the keyway inserts and heat shield were wiped clean.

11. After stops Nos. 10, 20, 30, 40, 45, and 50 the brake was disassembled and the expansion slots in the lining carriers were cleaned of excess lining material and opened. Excess materials removed from between the segments in the rotors and the lugs and links on the rotors were cleaned and radiused by machining processes. Thin is a sense is equivalent to a minor overhaul in the brake linings.

In addition there were at least four other major irregularities in the test procedure.

These, gentlemen, are only irregularities which occurred during the testing. As for the report itself more than 80 false entries were made in the body of the report and in the logs.

Many, many of the elaborate engineering curves attached to the report were complete and total fabrications, based not on what had actually occurred, but on information which would fool both LTV and the Air Force.

I have already mentioned that the turn-around capability test which was supposed to determine what temperatures might be experienced by the brake during a typical flight mission, had been misconducted through a human error on the part of the test lab operator.

Rather than rerun this very important test, which would have taken only some 6 hours to complete, it was decided to manufacture the data.

This we did, and the result was some very convincing graphic curves. These curves were supposed to demonstrate to LTV and the Air Force exactly what the temperatures in the brakes had been during each minute of the simulated mission

They were completely false and based only on data which would be acceptable to the customers.

I could spend the entire day here discussing the various elaborate falsifications that went into this report but I feel that, by now, the picture is clear.

The report was finally issued on June 5, 1968, and almost immediately, flights tests on the brake were begun at Edwards Air Force Base in California.

Mr. Lawson was sent by Goodrich to witness these tests and when he returned, he described various mishaps which had occurred during the flight tests and he expressed the opinion to me that the brake was dangerous.

That same afternoon, I contacted my attorney and after describing the situation to him, asked for his advice.

He advised me that, while I was technically not guilty of committing a fraud, I was certainly part of a conspiracy to defraud.

He further suggested a meeting with U.S. Attorney Roger Makely in Dayton, Ohio.

I agreed to this and my attorney said he would arrange an appointment with the Federal attorney.

I discussed my attorney's appraisal of our situation with Mr. Lawson, but I did not, at this time, tell him of the forthcoming visit with Mr. Makely.

Mr. Lawson said he would like to consult with my attorney and I agreed to arrange this.

Shortly thereafter, Mr. Lawson went to the Dallas offices of LTV and, while he was gone, my attorney called and said that, upon advice of the U.S. attorney, he had arranged an interview with the Dayton office of the FBI.

I related the details of the A–7D qualification to Mr. Joseph Hathaway, of the FBI.

He asked if I could get Mr. Lawson to confirm my story and I replied that I felt Mr. Lawson would surely do this.

Upon Mr. Lawson's return from Dallas, I asked him if he still wished to consult my attorney and he answered "I most certainly do."

Mr. Lawson and I went to the attorney's office, and Mr. Lawson was persuaded to speak to the FBI.

I wish to emphasize that at no time prior to Mr. Lawson's decision to speak to the FBI was he aware that I had already done so. His decision and mine were both the result of our individual actions.

Mr. Lawson related his own story to Mr. Hathaway, who advised us to keep our jobs and to tell no one that we had been to see him.

I might add here that he advised us that an investigation would be made.

About this time the Air Force demanded that Goodrich produce its raw data from the tests.

This Goodrich refused to do, claiming that the raw data was proprietary information.

Goodrich management decided that, since pressure was being applied by the Air Force, a conference should be arranged with LTV management and engineering staff.

A preconference meeting was set for Goodrich personnel in order to go over the questionable points in the report.

On Saturday, July 27, 1968, Mr. Robert Sink, Mr. Lawson, Mr. John Warren—A–7D project engineer—and I met and went over the discrepant items contained in the qualification report.

Each point was discussed at great length and a list of approximately 40 separate discrepancies was compiled.

These, we were told by Mr. Sink, would be revealed to LTV personnel the following week.

However, by the time of the meeting with LTV, only a few days later, the list of discrepancies had been cut by Mr. Sink from 43 items to a mere three.

Mr. Chairman, during this meeting Mr. Lawson took from the blackboard at the Goodrich conference room word for word listing of all these discrepancies. This contains the 43 items I have just mentioned.

I would like to enter this into the record, and also enter the subsequent list of three major discrepancies which later came out of this meeting.

Chairman PROXMIRE. Do you have copies of those documents?

Mr. VANDIVIER. Yes, I do have.

Chairman PROXMIRE. All right, those will be entered in the record.

(The documents referred to follow:)

A7D MEETING—JULY 27, 1968

PERSONNEL: R. L. Sink; J. H. Warren; K. W. Vandivier; and S. J. Lawson.
SUBJECT: Review of Data to Be Presented to LTV.

Item 1: A. 10 mph cut pressure:

(1) LTV concurrence.

(2) Brakes-on velocity increased to get correct energy into brake.

(3) Needed Item 1 because of constant pressure, torque build-up, small footprint of tire on smooth runway surface.

Item 2: A. Spacer:

(1) Dimensions indicated a possibility of running out of piston travel which would lose the 45 stop heat sink. Spacer added as a precaution.

(2) Measurement of lining and disks after O.L. stops shows that spacer was not required:

(a) Average stack wear after 45 stops plus clearance and deflection=.768.

(b) Average stack wear after O.L. plus clearance and deflection=.859.

(c) Minimum allowable pistol travel=.880.

(3) O.L. stops were run without adjusters at approximately 850 psi. Report was adjusted to show pressure used plus 140 psi for adjuster.

(4) As a result of marginal piston travel, pistons and sleeve redesign is in process.

(5) There would be no safety problem on A/C as brake removal is controlled by wear pin indicator.

Item 3: Spacer for RTO:

(1) Needed spacer for piston travel after O.L. and didn't want to lose worn brake RTO data.

(2) Specification was $2.+15\times10^6$ KE. BFG ran test at $2.+17.\times10^6$ KE. Specification was revised to $2.+17.\times10^6$ KE.

(3) Pressure plate was used as spacer so adjusters were in brake for RTO. As a result, raw data and report pressure data agree.

(4) Demonstration shows that heat sink is capable of specification RTO energy at any time prior to removal of brake for wear, as shown by wear indicators.

Item 4: A. Turn-Around Capability Test:

(1) Peak temperatures required by specification are confirmed by raw data. Cool down rates from raw data to be plotted on report graphs to determine variation.

(2) Bead seat and false axle required by specification.

(a) Phase I, Cycle 3 temperatures required by specification are accurate.

(b) Phase I, Cycle II, peaks are O.K., curves are off. The profile curves are manufactured.
(c) Phase I, Cycle III, some temperatures are manufactured.
(d) Phase II, temperatures manufactured. Bead seat thermocouple shorted out, false axle peaks at 411° F. reported 280° F.

(3) Normal energy stops are 1.0×10^6 KE higher than specification requires.

Item 5: A. Peak torque on the normal energy log sheets:

(1) Peaks were picked off tape data by data analysis checks. The peaks selected were actually a result of noise on the tape and not peak torque values. These were not detected when the report was checked. Example: Report shows stop #1 peak at 12,070 ft-lbs, it is actually 8,590 ft-lbs.

(2) Peak torque survey test valves are correct.

Item 6: A. (1) Tube well temperatures on normal energy log sheets were corrected on stops 3, 4, 5, 18, and 20.

(a) Recorded 379--Reported 270—Stop 3
(b) Recorded 428—Reported 379—Stop 4
(c) Recorded 428—Reported 255—Stop 5
(d) Recorded 375—Reported 255—Stop 18
(e) Recorded 375—Reported 239—Stop 20

Item 6: A (2) #2—360-360, #6—270-270, #19—379-379

(3) Stop 3 and 4 on log sheets have been reversed.
(4) Stop 5 was run as a hot park stop condition (operator error).
(5) Stop #33 tire change. Thermocouples for fuse plug, bead seat, and tubewell mixed up.

(a) Prior to stop #33, high to low temperature.
T.W.→B.S.→F.P.
(b) After stop #33, high to low tempreature.
B.S.→F.P.→T.W.

(Operator error.) Temperatures that are read for B.S. after stop #33 is for the T.W., etc., for F.P.→B.S. and T.W.→F.P.

Item 7:

A. Drag load and clearance:
(1) 34 was 16 lbs. changed to 10 lbs.
(2) 37 was 12 lbs. changed to 9 lbs.

B. Clearance was taken incorrectly, report what we felt was correct.

Item 8: A. Overloads:

(1) Temperatures

(a) Stop #46, CS thermocouple out—reported 1535° F.
CS on other O.L. stops 1512–1558–1562–1558
(b) #46 tubewell recorded 301, reported 192°F
#47 tubewell recorded 367, reported 367°F
#48 tubewell recorded 528, reported 422°F
#49 tubewell recorded 509, reported 463°F
#50 tubewell recorded no reading, reported 210°F

(2) Raw data temperatures for stop #47 correlates well. Send in for typical stop.

Item 9: A. Worn Brake RTO:

(1) P.H. recorded 390, reported 355
(2) F.A. recorded 521, reported 482
(3) B.S. recorded 590, reported 580
(4) F.P. recorded 486, reported 438
(5) T.W. recorded 669, reported 673
(6) Fluid recorded 400, reported 350
(7) Rotor recorded 2180, reported 2100

Item 10: A. New Brake RTO:

(1) P.H. recorded 471, reported 453
(2) Axle recorded 469, reported O.K.
(3) Tubewell recorded no data, reported 480

SUMMARY

Typical raw data to be supplied to LTV.

(1) Normals
  (a) #33—no fans
  (b) #35—with fans
(2) Overloads
  (a) #47

Note: Tell LTV that peak was reached after chart ended, for overload stop number 47.

(3) New RTO
  (a) O.K.
(4) Turn-Around—Cycle 3, Phase I

S. J. Lawson.

A7D Meeting—July 27, 1968

SUBJECT: TYPICAL RAW DATA TO BE SUPPLIED TO LTV

A. Normals
(1) Stops
  (a) #33—no fans
  (b) #35—with fans
(2) 10 mph cut pressure
  (a) LTV concurrence
  (b) Brakes-on velocity increased to get correct energy into brake.
  (c) Needed Item 1 because of constant pressure, torque build-up, small footprint of tire on smooth steel road surface.

B. Overloads
(1) Stops (a) #47
(2) Spacer
  (a) Dimensions indicated a possibility of running out of piston travel which would lose the 45 stop heat sink. Spacer added as a precaution.
  (b) Measurements of lining and disks after O.L. stops shows that spacer was not required.
    i. Average stack wear after 45 stops plus clearance and deflection=.768.
    ii. Average stack wear after O.L. plus clearance and deflection=.859.
    iii. Minimum allowable piston travel=.880.

B. Overloads
(2) Spacer (cont'd)
  (c) O.L. stops were run without adjusters at approximately 850 psi. Report was adjusted to show pressure used plus 140 psi for adjuster.
  (d) As a result of marginal piston travel, pistons and sleeve redesign is in process.
  (e) There would be no safety problem on A/C as brake removal is controlled by wear pin indicator.

C. New brake RTO (1) Tubewell recorded no data, reported 480.

D. Turn-Around—Cycle 3, Phase I

E. Peak torque on normal energy log sheets.
  (1) Peaks were picked off tape data by data analysis clerks. The peaks selected were actually a result of noise on the tape and not peak torque values. These were not detected when the report was checked. Example: Report shows stop #1 peak at 12,070 ft-lbs; it is actually 8,590 ft-lbs.
  (2) Peak torque survey test values are correct.

Mr. Vandivier. The following 2-month period was one of a constant running battle with LTV and the Air Force, during which time the

Air Force refused final approval of the qualification report and demanded a confrontation with Goodrich about supplying raw data.

On October 8, another meeting was held, again with Mr. Sink, Mr. Lawson, Mr. Warren, and myself present.

This was only 1 day prior to a meeting with Air Force personnel and Mr. Sink said he had called the meeting "so that we are all coordinated and tell the same story."

Mr. Sink said that LTV personnel would be present at the meeting with the Air Force and our policy would be to "Let LTV carry the ball." Mr. Sink appeared to be especially concerned because Mr. Bruce Tremblay, the Air Force engineer most intimate with A7D brake would be present at the meeting and it was felt at B. F. Goodrich that Mr. Tremblay was already suspicious.

Mr. Sink warned us that "Mr. Tremblay will probably be at his antagonistic best."

He added that the Air Force had wanted to meet at the Goodrich plant, but that we—Goodrich—couldn't risk having them that close to the raw data.

"We don't want those guys in the plant," Mr. Sink said.

What happened at the meeting with the Air Force, I do not know. I did not attend.

On October 18, I submitted my resignation to Goodrich effective November 1.

I would like to read that resignation. This is addressed to Russell Line, manager of technical services:

> In May of this year I was directed to participate in the preparation of qualification report for the A7D, 26031. As you are aware this report contained numerous deliberate and wilful misrepresentations which according to legal counsel constitutes fraud and therefore exposes both myself and others to criminal charges of conspiracy to defraud. In view of this fact, I must terminate my employment with the B. F. Goodrich Company effective November 1, 1968. I regret that this decision must be made, but I am sure that you will agree that events of the past seven months have created an atmosphere of deceit and distrust in which it is impossible to work effectively and productively.

On October 25 I was told that my resignation was to be accepted immediately, and within 20 minutes I had left the Goodrich Co.

Gentlemen, I am well aware that the B. F. Goodrich Co. is a well-known and well-respected firm with an almost impeccable reputation.

I am equally aware that the charges I have made are serious.

However, everything I have said to you is completely true and I can prove my statements with documentary evidence.

The unfortunate part of a situation such as this is that, invariably, many innocent persons are made to suffer along with the guilty.

Therefore, I should like to emphasize that three people whom I have mentioned here are, I feel, completely blameless and were implicated in this situation through no fault of their own.

Mr. Ralph Gretzinger from the very start fought this situation and tried very hard to use his influence to stop the issuance of the false report.

Mr. Richard Gloor, in his own handwriting, listed the irregularities occurring during the test and was outspoken in his opposition to the report.

This list was shown to B. F. Goodrich management.

Mr. Lawson, of course, was in a position similar to mine and the fact that he voluntarily disclosed the details of the A7D test program to the FBI and the GAO should stand upon its own merits.

Thank you.

Chairman PROXMIRE. Thank you, Mr. Vandivier.

Mr. Lawson, you have heard the statement as read and I take it you have had a chance to see the full statement?

Mr. LAWSON. No, I have not.

Chairman PROXMIRE. You have not?

Mr. LAWSON. No, I have not.

Chairman PROXMIRE. The statement you have just heard read by Mr. Vandivier, do you agree with it fully or in part or do you disagree and can you tell us your reaction to it?

Mr. LAWSON. The factual data that Mr. Vandivier has presented is correct, to the best of my knowledge.

Chairman PROXMIRE. There is no statement that you heard him read with which you would disagree in any part?

Mr. LAWSON. I really don't know. I haven't read the complete text.

Chairman PROXMIRE. Would you disagree with any part of what you heard him read right now in your presence?

Mr. LAWSON. No, I don't believe there is.

Chairman PROXMIRE. Now I would like to ask you, Mr. Vandivier, you gave us a picture which we may want to ask other witnesses about, so I want to qualify that picture. As far as we know, it is a picture which you say was taken of the brake that was tested?

Mr. VANDIVIER. That is correct.

Chairman PROXMIRE. But we would like to make sure that we qualify that, because it is going to be used later.

Now would you describe again, tell us how you came to have that, when the picture was taken and so forth?

Mr. VANDIVIER. Yes. This was taken just approximately an hour and a half or 2 hours before the worn brake RTO was conducted. This was for the qualification test, and I asked the plant photographer if he would take a Polaroid picture of this for me. He did so, and I took the Polaroid shot and I had it enlarged. I have a certification on this. I had the original Polaroid negative. I have the negatives that the photographer used.

Chairman PROXMIRE. Will you give us the date, the time that was taken, if you have that?

Mr. VANDIVIER. If you will give me just a moment, I can.

Chairman PROXMIRE. Meanwhile, may I ask Mr. Lawson, while Mr. Vandivier is looking up that, if you can confirm that this is in fact the picture of the A7D brake that was undergoing qualification?

Mr. LAWSON. Yes, it appears to be.

Chairman PROXMIRE. It appears to be?

Mr. LAWSON. I would say it is.

Chairman PROXMIRE. It is. All right. Well, you can supply that a little later for the record, Mr. Vandivier.

Mr. VANDIVIER. All right.

Chairman PROXMIRE. Let me ask you this. You say you worked for Goodrich for 6 years?

Mr. VANDIVIER. That is correct.

Chairman PROXMIRE. What was your previous employment before you were hired by Goodrich?

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Mr. VANDIVIER. I worked for the Food Machinery and Chemical Corp. at their Newport, Ind. plant.

Chairman PROXMIRE. Technical writer is a professional position that requires considerable competence and ability. What experience did vou have that would qualify you to be a technical writer?

Mr. VANDIVIER. I had none.

Chairman PROXMIRE. Did you immediately go into this or did they give you a training course?

Mr. VANDIVIER. No. I had no training course. I kind of worked into the job I guess. It was——

Chairman PROXMIRE. You were not hired to be a technical——

Mr. VANDIVIER. No; I was actually hired as an instrumentation technician, and Goodrich engaged in a mass changeover of instrumentation techniques, and they wanted degreed people for this kind of work so I was switched over to the technical writing section.

Chairman PROXMIRE. How long did you work as a technical writer?

Mr. VANDIVIER. Approximately 3 years.

Chairman PROXMIRE. Three years. How many reports did you prepare for B. F. Goodrich?

Mr. VANDIVIER. At least 100, possibly 150.

Chairman PROXMIRE. Were any of these reports questioned in any way?

Mr. VANDIVIER. No; they were not.

Chairman PROXMIRE. Were they accepted? Did you get any reaction at all favorable or unfavorable in these reports that you wrote?

Mr. VANDIVIER. Occasionally we would get a question from the manufacturer about a wording or a clarification, and these would be supplied.

Chairman PROXMIRE. Was there any question as to the accuracy or competence of the report?

Mr. VANDIVIER. No; none whatsoever.

Chairman PROXMIRE. Were you criticized at any time that the reports were not adequate?

Mr. VANDIVIER. No; I was not.

Chairman PROXMIRE. In your statement, you say "Accordingly I wrote the report but in the conclusion I stated that the brake had 'not' met either the intent or the requirement of the specification and therefore was 'not' qualified." Then you add "When the final report was typewritten and ready for publication the two 'nots' in the conclusion had been eliminated, thereby changing the entire meaning of the conclusion."

Now it seems to me that you have testified before this that you and Mr. Lawson constructed this report based on your instructions from your superiors, and that this report was false in many ways that you knew, and that the report seemed to qualify the brakes, at least that was the impression I got, and yet you concluded, and I quote, "I stated the brake had not met either the intent or the requirement of the specifications and therefore was not qualified."

Doesn't it seem on the basis of your testimony that this is somewhat inconsistent? In other words, you had written a report that would qualify the brake and then you come in with a one-sentence conclusion in which you say it was not qualified? Do you see what I am getting at?

Mr. VANDIVIER. Yes. Mr. Chairman, this was probably one final gesture of defiance. I was so aggravated and sick at having to write this thing. I knew the words "not" would be taken out, but I put them in to show that, I do not know, that they had bent me to their will but they had not broken me yet. It was a foolish thing perhaps to do, but it was showing that I still had a little spirit left. At least this is how I felt.

Chairman PROXMIRE. What did you think your superiors at B. F. Goodrich would do when they found the "not qualified" in your report, when you had been told to show the brake qualified?

Mr. VANDIVIER. I knew it would be changed probably without question. I was not worried if you are trying—I was not worried at being called on the carpet for this. I knew they would just merely change it.

Chairman PROXMIRE. Was this the only time in the 3 years you worked as a technical writer with Goodrich the only time that you made false entries into a report of manufacture?

Mr. VANDIVIER. Yes, it was.

Chairman PROXMIRE. So as far as you know B. F. Goodrich's record is clean in every other respect with your experience?

Mr. VANDIVIER. With me——

Chairman PROXMIRE. With this single incidence being an exception?

Mr. VANDIVIER. That is right; that is correct.

Chairman PROXMIRE. They had never before ask you to do this?

Mr. VANDIVIER. No.

Chairman PROXMIRE. Do you know of any other technical writer you worked with, in which Goodrich had instructed them to take this kind of action?

Mr. VANDIVIER. If they had done this, I would know nothing of it. I could not say.

Chairman PROXMIRE. This was the only incident?

Mr. VANDIVIER. Yes, as far as I know, the only incident which I was asked to do this.

Chairman PROXMIRE. What was the normal procedure at Gooodrich when a brake failed to meet all of the requirements or when normal procedures were not followed?

Mr. VANDIVIER. If for some reason or other the normal procedure was not followed or the brake simply could not meet a particular requirement, the report was written and a deviation was requested from the manufacturer, which in other words is a request to allow him to accept the brake with these noted deviations from the procedure.

I might add that there are many times that a brake just could not meet a certain requirement specified by the manufacturer, and it was always the customary procedure to ask for a deviation, and many times it was granted or some sort of a compromise was reached between the manufacturer and Goodrich.

Chairman PROXMIRE. I cannot understand what was going through the minds of Goodrich's management the way you have told the story. I cannot see what they have to gain by passing on a brake that would not meet qualifications. Somewhere along the line this is going to be shown as an unqualified brake. As you pointed out, it might be under disastrous circumstances, but in any event Goodrich would suffer and suffer badly by passing on a brake to LTV or the Air Force that was not going to work. What is their motivation?

Mr. VANDIVIER. I cannot tell you what their motivation is. I can tell you what I feel was behind this.

Chairman PROXMIRE. All right.

Mr. VANDIVIER. I feel in the beginning stages of this program someone made a mistake, and refused to admit that mistake, and in order to hide his stupidity, or his ignorance, or his pride, or whatever it was, he simply covered up, you know, with more false statements, false information, and at the time it came time to deliver this brake, Goodrich was so far down the road there was nothing else to do.

They had no time to start over. I think it was a matter not of company policy but of company politics. I think that probably three or four persons within the Goodrich organization at Troy were responsible for this. I do not believe for a moment that the corporate officials in Akron knew that this was going on.

Chairman PROXMIRE. I think that is right. I agree. I cannot imagine the top corporate officials deliberately lying about this. They have no motivation. All they can do is lose. All it can do is cause embarrassment, grief, loss, loss of respect and reputation, and I am sure that they would be very much opposed to this if they had known what was going on.

Well, I have a few more questions. I will be back.

Congressman Conable?

Representative CONABLE. Thank you, Mr. Chairman.

Mr. Vandivier, all we want to learn here is the facts, of course. It is a confusing business for a layman. I would like to ask yon, you testified that you have a high school degree, and from that I assume that you had no great engineering experience beyond that which you gained from your work, is that correct?

Mr. VANDIVIER. That is right. That is correct.

Representative CONABLE. Are you expected to make engineering judgements in your work as a technical writer or are you supposed to report facts?

Mr. VANDIVIER. Mil-W-5013 G, which is the controlling specification for aircraft wheels and brakes, spells out specifically what shall be done and what shall not be done during testing. It does not tell the user how to arrive at the engineering decisions, but it does tell him how this test shall be conducted, and this is written in black and white, and you have only to understand what shall be done according to this specification and what shall not. Do you understand what I am saying?

Representative CONABLE. Yes, I understand what you are saying. In other words, the answer is that you are not supposed to make engineering judgements as such, but you are supposed to follow the procedure?

Mr. VANDIVIER. That is correct.

Representative CONABLE. Were you motivated in any way with respect to this brake except by the circumstances? Did you have any involvement in the decision to make this type of brake or was there any reason why you delved so deeply into it as a technical writer?

Mr. VANDIVIER. I don't quite understand the question, Mr. Congressman.

Representative CONABLE. Did you have anything to do with the development of this brake other than the technical writing and the reporting of what procedures had been followed in the generation of this report?

Mr. VANDIVIER. A part of my job at Goodrich was to analyze the data that came from the tests. In other words, all of the raw test data such as temperatures, torque readings, speeds, and so forth, and then convert this information into a suitable form for B. F. Goodrich engineering. As far as any design changes or anything like that, anything to do with the design of the brake, no, I had nothing to do with that.

Representative CONABLE. You have testified that you had made many reports previously to B. F. Goodrich. Were any of these for the Federal Government?

Mr. VANDIVIER. Oh, yes; quite a few.

Representative CONABLE. And you have also said that you are not aware of any misstatements of fact in any of the earlier reports. Were there any done under different personnel than the personnel you were working under in respect to this particular brake?

Mr. VANDIVIER. Some of them were and some of them were not. For instance, the C-5A; Mr. John Warren was the project engineer on the C-5A, isn't that correct, Mr. Lawson?

Mr. LAWSON. Yes.

Mr. VANDIVIER. And Mr. Warren was also the project engineer on the A-7D. On the C-5A, which had very, very stringent requirements, we had engineering requirements, we had engineering problems on the brake, but there were no discrepancies in the testing. The thing was tested to the requirements.

Representative CONABLE. Referring to your statement, wherein you say that there were 80 false entries. You made notes of those, did you, what they were?

Mr. VANDIVIER. Yes.

Representative CONABLE. Do you know if they were confirmed by the GAO audit? Did you discuss this with them?

Mr. VANDIVIER. I discussed this with GAO. I do not know what the extent of their audit was.

Representative CONABLE. You mentioned that you have documentation available for this?

Mr. VANDIVIER. That is correct.

Representative CONABLE. What is the nature of this documentation?

Mr. VANDIVIER. The documentation I have supplied consists of Xeroxed copies of the raw test data.

Representative CONABLE. I wonder is it in a form that we could make it part of the record so that we could have it analyzed?

Mr. VANDIVIER. I believe it is.

Representative CONABLE. If it is, I wonder if we should not have it made part of the record.

Chairman PROXMIRE. Absolutely. That is a good suggestion. Without objection that will be made part of the record at this point.

(The material furnished for the record at this point follows on p. 19:)

B.F.GOODRICH AEROSPACE & DEFENSE PRODUCTS

Wheel and Brake Plant

Troy, Ohio

REPORT NO. Q-6031
Qualification of the
B.F.Goodrich P/N 2-1162-3
MLG Brake Assembly
for the
LTV A7D Aircraft
June 5, 1968
Contract No: N00019-67-C-0143
P-237138AER
Item 5

H. C. Sunderman
H. C. Sunderman
Chief Engineer

E. H. Lehman
E. H. Lehman
DSAQAR

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APPENDIX

APPENDIX

INTRODUCTION

This report presents the results of qualification tests conducted on the B.F. Goodrich Part Number 2-1162-3 Main Landing Gear Brake Assembly for the LTV A7D Aircraft.

Test procedures and requirements were derived from Military Standard MIL-W-5013G, LTV Specification Document 204-16-37d, and B.F.Goodrich Engineering Report ER-2731, Revision "E".

All tests were conducted at the B.F.Goodrich Wheel and Brake Plant, Troy, Ohio.

Tests were conducted under the following Internal Test Request Numbers:

T-1906	45 Stop, 5 Stop, and Worn Brake RTO.
T-1867	New Brake RTO.
T-1572	Extreme Temperature, Endurance, Leakage.
T-1904	New Brake Peak Torque Survey, Structural Torque.
T-1724	Worn Brake Peak Torque Survey.
T-1720	Piston Housing Burst Test.
T-1859	Turn-Around Capability Test.
T-1930	Salt Atmosphere Test.

I. COMPLIANCE SHEET

1. SCOPE

The equipment was designed specifically for the A7D light attack aircraft.

2. APPLICABLE DOCUMENTS

2.1 SPECIFICATIONS

Compliance was maintained where applicable to the documents referenced in LTV Procurement Specification 204-16-37d.

2.2 GOVERNMENT DOCUMENTS

Compliance was maintained as in Paragraph 2.1.

2.3 PRECEDENCE OF SPECIFICATIONS

When difference in specifications arose, compliance was maintained to LTV Procurement Specification 204-16-37d, or where LTV Specification 204-16-37d was not applicable, the order of precedence established by MIL-STD-143.

2.4 DEVIATIONS

No deviations are required.

2.5 VENDOR SPECIFICATION OPTION

It was not necessary to use later issues of the specifications referenced.

2.6 OBTAINING DOCUMENTS

Not applicable to the preproduction testing and qualification of the brake.

3. REQUIREMENTS

3.1 PREPRODUCTION

This report is for the preproduction testing and qualification of the 2-1162-3 brake assembly.

I. COMPLIANCE SHEET (cont'd)

3.2 GENERAL SPECIFICATION

The requirements of MIL-W-5013G were adhered to during testing except where they differed from LTV Procurement Specification 204-16-37d.

3.3 DESIGN AND CONSTRUCTION

3.3.1 Functional Characteristics

It was proven through dynamic and static tests, as covered in the appendix (Page A-1) of this report, that the 2-1162-3 main wheel brake will provide adequate braking during landing and parking for the A7D light attack aircraft.

3.3.2 Size and Configuration

The brakes tested were of a size and configuration that was in accordance with VAD Drawing 216-34302.

3.3.3 Weight

3.3.3.1 Existing Design

Not applicable, the brake was a new design effort. Weight reports were supplied as required.

3.3.3.2 New Design

The brakes tested were within the limits specified in EEP-8092, which was the lightest practical design to fulfill the requirements for the A7D light attack aircraft.

3.3.4 ENVIRONMENTAL CONDITIONS

3.3.4.1 Vibration

The brakes tested demonstrated the ability to exceed the vibration requirements of LTV Procurement Specification 204-16-37d. The loads sustained during the wheel and brake preproduction tests exceed those required by the vibration spectrum.

I. COMPLIANCE SHEET (cont'd)

3.3.4.2 Altitude

The brakes will withstand the altitude requirements of LTV Procurement Specification 204-16-37d. This is substantiated by the similarity to existing brakes and their successful operation.

3.3.4.3 Sand and Dust

Due to the similarity of material, except for the heat sink, between the B. F. Goodrich 2-1118 brake assembly and the 2-1162-3 brake assembly, the data obtained from the environmental tests of the 2-1118 brake assembly is submitted in report number 68092 (see appendix of report) to demonstrate that the 2-1162-3 brake assembly meets the requirements of LTV Procurement Specification 204-16-37d.

3.3.4.4 Fungus

Same as section 3.3.4.3

3.3.4.5 Salt Atmosphere

The 2-1162-3 brake assembly was tested to the salt atmosphere conditions of MIL-STD-810A, Method 509.1. This test did not result in any damage that would diminish the performance of the brake.

3.3.4.6 Humidity

The brake assembly will withstand the humidity requirements of LTV Procurement Specification 204-16-37d substantiated by similarity in design to existing brakes and their successful operation.

3.3.4.7 Moisture

The brake assembly will withstand the moisture requirements of LTV Procurement Specification 204-16-37d as evidenced by similarity to existing brakes and their successful operation.

I. COMPLIANCE SHEET (cont'd)

3.3.4.8 Temperature

The brake assembly temperature capability was proven to exceed the high temperature requirements of LTV Procurement Specification 204-16-37d as demonstrated by the dynamic brake portion of the qualification testing. The low temperature requirement is covered in report number 680921 (see Paragraph 3.3.4.3).

3.3.5 Special Tools

None required.

3.3.6 Tolerance and Simplicity

Compliance with specification was maintained. Tolerances consistent with current design practice were used to insure maximum producibility and simplicity of design.

3.3.7 Installation

The items tested were to the requirement of LTV Procurement Specification 204-16-37d. The rotors are designed so that they must be properly fitted to the wheel brake drives (B.F.Goodrich Part No. 170-126) or the wheel assembly cannot be assembled on the axle.

3.3.8 Fastener Requirements

Compliance was maintained with LTV Procurement Specification 204-16-37d. Tapped holes in aluminum were used only in non-critical areas and then were protected with inserts. Snap rings were used as a back-up method of retention on the 107-240 adjuster assembly.

3.3.9 Static Balance

Not applicable to brake assembly qualification.

3.3.10 Structural Torque

The brake assembly withstood the static torque requirement of 250,000 in-lbs. (See page (26) section (IV) of this report).

I. COMPLIANCE SHEET (cont'd)

3.3.11 Wear

The brake assemblies showed no evidence of abnormal wear during the preproduction tests.

3.3.12 Maintainability

The brake assembly can be replaced or serviced under field conditions. Automatic adjusters eliminate the need for field adjustment. (See B.F.Goodrich Technical Manual 2367 in the appendix of this report.)

3.3.13 Main Wheel

Not applicable to brake assembly qualification.

3.3.13.1 Bearings

Not applicable to brake assembly qualification.

3.3.13.2 Tire pressure Relief

The main wheel has three 392 degree Fahrenheit temperature sensitive pressure relief devices installed adjacent to the brake. A temperature survey was conducted on the pressure relief devices during the turn-around capabilities tests. The results of the survey, showing time to release and temperature at release, are shown in the appendix of this report. The time for release and temperature of release after an RTO stop is 12.5 minutes after the stop at a temperature of 431 degrees fahrenheit. The data is shown in the appendix of the report, page A-67.

3.3.13.3 Tire Mounting and Dismounting Provisions

This requirement was demonstrated during the dynamic torque test portion of the preproduction testing.

3.3.13.4 History Device

Not applicable to brake assembly qualification.

3.3.13.5 Wheel Loads

Not applicable to brake assembly qualification.

I. COMPLIANCE SHEET (cont'd)

3.3.13.5.1 Load (Per Wheel)

Not applicable to brake assembly qualification.

3.3.13.6 Lubrication

Not applicable to brake assembly qualification.

3.3.13.7 Exciter Ring

Not applicable to brake assembly qualification.

3.3.14 Brake

The 2-1162-3 brake assembly is a heat sink type brake with four automatic adjuster assemblies which provide an indicator to determine when a lining change is required. The brake assembly has two bleeder ports and two inlet ports; and is interchangeable with no right or left hand parts. The brake assembly has two bosses on the piston housing for mounting a wheel speed sensor.

3.3.14.1 Brake Inlet Port

The brake assembly inlet ports conform to AND 10050 and are capable of accomodating a shuttle valve. The inlet ports are located on the back of the piston housing to provide maximum protection for the shuttle valve and plumbing from blowout hazards and objects on the ground.

3.3.14.2 Kinetic Energy

The 2-1162-3 Main Wheel Brake Assembly was tested to the conditions of LTV Procurement Specification 204-16-37d. A 2.0×10^6 plus 17.0×10^6 ft-lb RTO was conducted on the same heat sink that was used for the 45 and 5 stop test. (This test is per MIL-W-5013G) The results of this test are shown in Section IV of this report.

3.3.14.3 Back Pressure

The adjuster assemblies maintained the proper brake clearance with the steady state back pressure applied to the brake during the preproduction tests.

I. COMPLIANCE SHEET (cont'd)

3.3.14.4 Operating Pressure and Displacement

Compliance was maintained during the preproduction testing. The fluid displacement did not exceed two cubic inches.

3.3.14.5 Fluid

MIL-H-5606 hydraulic fluid was used for all preproduction test. The seals used in the brake are compatible with MIL-H-5606.

3.4 PERFORMANCE

3.4.1 Main Wheel

Not applicable to brake assembly preproduction test qualification.

3.4.1.1 Inclined Roll Test

Not applicable to brake assembly preproduction test qualification.

3.4.1.2 Wheel Bolt Torque

Not applicable to brake assembly preproduction test qualification.

3.4.2 TURN-AROUND CAPABILITY REQUIREMENTS

The main wheel brake assembly was subjected to the turn-around capability conditions, except that the normal energy landings were made with 11.0×10^6 ft-lbs of energy rather than 10.0×10^6 ft-lb of energy. This was done to further demonstrate the ability of the brake to cool down to normal operating temperatures within the time span given by LTV Procurement Specification 204-16-37d.

At no time during the turn-around test, except for the RTO Stop, did the bead seat temperature exceed 350 degrees Fahrenheit. The data obtained from the turn-around capability tests are shown in the appendix of this report.

Fluid displacement	2.0
Rotation Force	10 lbs.

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I. COMPLIANCE SHEET (cont'd)

3.4.3 BRAKES

3.4.3.1 Actuation

Compliance with this requirement was maintained. The brake has been designed to provide satisfactory running clearance throughout the life of the brake.

3.4.3.2 Release

Compliance with this requirement was maintained. The tire and wheel assembly was checked before every stop to see if it was free to rotate. On every fifth stop the tangential force required to rotate the tire and wheel assembly was recorded. (See brake tests logs in appendix of report, page A-2.)

3.4.3.3 Leakage

Compliance with this requirement was maintained. No leakage was present during the entire qualification testing.

3.4.3.4 Performance at Elevated Temperature

Compliance with this requirement was maintained. There was no degradation of material properties which would affect fatigue or service life.

3.5 INTERCHANGEABILITY

The main wheel brake assembly meets the interchangeability requirement of LTV Procurement Specification 204-16-37d.

3.6 DESIGN CHANGES

Compliance will be maintained as required by LTV Procurement Specification 204-16-37d.

I. COMPLIANCE SHEET (cont'd)

3.7 MATERIALS

The brake piston housing is made of forged aluminum alloy, the remainder of the components are made of corrosion resistant materials or are suitably protected to prevent corrosion. A forty-eight hours salt atmosphere was conducted on the brake according to MIL-STD-810. The condition of the brake was excellent after this test. (See photographs in appendix of report.)

3.8 STANDARD PARTS

All bolts used in the brake assembly are of AN, MS, or NAS standard configuration. (See Part List in the appendix of this report.)

3.9 IDENTIFICATION OF PRODUCT

The brake has forged lettering on the piston housing which identifies it per MIL-STD-130.

3.10 WORKMANSHIP

Compliance is maintained to this requirement. The test brakes were of the same level of workmanship as production.

3.11 FINISH

The production brakes are finished to the required military specifications. The brakes used for preproduction testing were not painted (except for the salt atmosphere test) to allow periodic inspection.

3.12 STORAGE

The production brake assemblies meet this requirement.

3.13 MAINTAINABILITY

No special equipment is required to maintain the main wheel brake assembly.

I. COMPLIANCE SHEET (cont'd)

3.13.1 MAINTAINABILITY DATA

The maintainability data required by LTV Procurement Specification 204-15-1d has been supplied to LTV Vought Aeronautics Division, (also included in appendix of this report).

3.15.2 MAINTENANCE CONCEPTS

The maintenance data and manuals required by LTV Procurement Specification 204-15-1d has been supplied to LTV Vought Aeronautics Division, (also included in the appendix of this report).

3.16 RELIABILITY

The main wheel and brake reliability analysis is included in the appendix of this report.

4. QUALITY ASSURANCE PROVISIONS

4.1 CLASSIFICATION OF TESTS

(a) Preproduction - The brakes tested were of the same configuration and of the production items.

(b) Individual - Not applicable to brake preproduction tests or qualification.

(c) Acceptance - Not applicable to brake preproduction tests or qualification.

4.2 PREPRODUCTION TESTS

4.2.1 Sampling

See preproduction test plan, Part 2, section 2.3.

4.2.2 TEST SCHEDULE

Test schedules were submitted as required.

4.2.3 Order of Testing

The tests were conducted according to the approved preproduction test plan.

I. COMPLIANCE SHEET (cont'd)

4.2.4 Representative

No restrictions were placed at anytime on a representative being able to witness or conduct tests.

4.2.5 Preproduction Model Approval

This report is submitted to gain approval for the preproduction model and tests.

4.2.6 Preproduction Test Report

Five copies of this report will be submitted to LTV Vought Aeronautics Division.

4.3 INDIVIDUAL TEST

The brake assembly procedure has been submitted to LTV Vought Aeronautics Division and was accepted, (also included in appendix of this report).

4.3.1 Tests

All testing was in accordance with MIL-W-5013G except where modified by LTV Procurement Specification 204-16-37d.

4.3.1.1 Disassembly and Inspection

The brake assemblies were completely disassembled after tests and inspected. The photographs of the test articles are included in the appendix of this report.

4.3.1.2 Tire Pressure Relief

Please see paragraph 3.3.13.2 of this section.

4.3.1.3 Roll Test

Not applicable to brake assembly preproduction tests or qualification.

4.3.1.3.1 Inflation Pressure

Not applicable to brake assembly preproduction tests or qualification.

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I. COMPLIANCE SHEET (cont'd)

4.3.1.3.2 Distance

Not applicable to brake assembly preproduction tests or qualification.

4.3.1.4 Lubrication

Not applicable to brake assembly preproduction tests or qualification.

4.3.1.5 Nut Life

Not applicable to brake assembly preproduction tests or qualification.

4.3.1.6 Endurance

Compliance was maintained with the requirements of MIL-W-5013G paragraphs 4.5.15 and 6.3.2. The results of the tests are in Section IV of this report.

4.3.1.7 Parking Test

Compliance was maintained with this requirement. On stop 3, 8, 13, 18, 23, 28, 33, 38, and 43 the brake was parked at maximum pressure with no cooling. The temperature profile data aquired from this test is included in the appendix of this report. It was demonstrated that the brake was free to rotate after these stops by turning the wheel by hand. The force required to rotate the wheel was in accordance with Paragraph 3.4.3.2 of this section.

4.3.1.8 Dynamic Torque Test Timing

Compliance was maintained with this requirement. The brake was allowed to cool to at least 150 degrees Fahrenheit between stops during the forty-five, five, and one stop test.

4.3.1.9 Temperature

The test axle was designed to provide the same heat sink characteristics as the aircraft axle as defined by VAD Drawing 215-34040.

I. COMPLIANCE SHEET (cont'd)

4.3.1.9 Temperature (cont'd)

A temperature profile was conducted on the false axle which rests directly on the aircraft axle. This temperature profile was conducted on the false axle during the turn-around capability test of section 3.4.2 and the kinetic energy tests of Section 3.3.14.2. The results are presented in the appendix of this report. At no time did the false axle temperature reach or exceed 550 degrees Fahrenheit.

4.3.1.10 Data

Sufficient data was taken during the dynamic torque tests to define an envelope of pressure versus torque. This data is presented in section (IV) paragraph 1.2 of this report.

4.3.1.11 Failure Tests

Not applicable to the brake assembly preproduction tests or qualification.

4.4 Acceptance Tests

Not applicable to the brake assembly preproduction tests or qualification.

4.5 Rejection and Restart

Compliance was maintained.

4.6 Test Conditions and Test Method

Test conditions were in accordance with the applicable military specification except where altered by LTV Procurement Specification 204-16-37d.

4.7 Disposition of Test Parts

Test parts will be shipped to LTV Vought Aeronautics Division for engineering evaluation. The items will be clearly marked as preproduction test items.

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I. COMPLIANCE SHEET (cont'd)

5. PREPARATION FOR DELIVERY

Not applicable for brake assembly preproduction tests. Full compliance will be maintained for production brake assemblies.

6.1 <u>BIDDING REQUIREMENTS</u>

Not applicable to brake assembly preproduction tests.

6.2 <u>CONTRACTUAL DATA</u>

Required data has been supplied to LTV Vought Aeronautics Division.

7. NOTES

Not applicable to preproduction testing and qualification of the product.

II. CONFIGURATION

1. Brake Assemblies

1.1 B.F.Goodrich Part Number 2-1162
(Identical to the 2-1162-3 brake in structure and hydraulics)

Extreme Temperature Tests
Leakage Test
Static Test

1.2 B.F.Goodrich Part Number 2-1162-3
(Parts List, Page A-90)

Normal Energy Stops
Overload Stops
Worn Brake RTO
Peak Torque Surveys
Structural Torque
Turn-Around Capability

B.F.Goodrich Part Number 2-1162-3

Brake Burst Test

B.F.Goodrich Part Number 2-1162-3

New Brake RTO

1.3 B.F.Goodrich Part Number 2-1162-3
(This brake assembly added to test requirements per LTV Engineering Instructions.)

Salt Atmosphere Test

2. Wheel Assembly

B.F.Goodrich Part Number 3-1293-1
Parts List, Page A-91

III. TEST EQUIPMENT

1. Dynamometers

1.1 84-inch (Flywheel Diameter), Adamson-United Company
Inertia Equivalent - 1797 to 19,794 pounds
Flywheel Peripheral Speed - 0 to 130 mph
Wheel Load to 25,000 pounds
Standard Dynamometer Instrumentation

1.2 120-inch (Flywheel Diameter), Adamson-United Company
Inertia Equivalent - 7511 to 49,763 pounds
Flywheel Peripheral Speed - 0 to 250 mph
Wheel Load to 60,000 pounds
Standard Dynamometer Instrumentation

2. Hydraulic Test Panel

B.F.Goodrich Special Design
Cycle Rate 0 to 60 cpm
Pressure - 0 to 5000 psi

3. Hydraulic Pump

Blackhawk Porta Power
0 to 5000 psi

4. Extreme Temperature Equipment

Blue M Electric Company, Manufacturer
Model FTBR-27-60WC-HEG/1004-27
Serial Number: R2C4-102
Range: -100° F to +400° F

5. Oscillograph

Midwestern Instruments Corporation
Model 621
No Serial Number
Direct-Writing Light Beam

6. Tape System

Bell and Howell, Manufacturer
14 Channel
Model VR-3400

III. TEST EQUIPMENT

7. Salt Spray Chamber

Industrial Filter and Pump Company
Type CA3 Chamber
Serial Number: 1290

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IV. RESULTS

Before undergoing formal qualification tests, all test specimens were subjected to the standard quality control inspections of the B.F.Goodrich Company and as required by MIL-W-5013G, Paragraphs 4.5.1 through 4.5.4.

1. Dynamic Brake Tests

1.1 Normal Energy Stops

1.1.1 Specification Reference

MIL-W-5013G, Paragraph 4.5.11 and Table 1.
LTV Specification Document 204-16-37d, Para. 4.3.1.10
BFG ER-2731, Revision "E"

1.1.2 Requirements

45 normal energy stops shall be conducted to the conditions presented in Table 1.

TABLE 1

Test Conditions	Energy Condition			
	Normal	Overload	RTO 1*	RTO 2*
Number of Stops	45	5	1	1
KE - ft-lbs x 10^6	12.01	13.95	2.135	18.09
IE - lbs	18273	16928	18311	18311
Landing Velocity - mph	140.3	156.94	59.0	171.6
Stop Time - sec.	22.1	23.0	--	25.2
Inflation - psi	270	270	270	270
Wheel Load	18,100	18,100	18,100	18,100
Back Pressure - psi	140	140	140	140

*These 2 stops comprise the RTO condition for the brake. These stops shall be conducted in rapid succession with elapsed time not to exceed five (5) minutes.

IV. RESULTS

1. Dynamic Brake Tests (continued)

1.1 Normal Energy Stops (continued)

1.1.2 Requirements (continued)

After normal energy stops 3, 8, 13, 18, 23, 28, 33, 38, and 43, while energy absorbing members are at their peak temperature, increase the brake pressure to 1000 psi. Cooling fans will be turned on when the beadseat temperature reaches its peak value.

After normal energy stops 3, 18, and 38, no cooling shall be used until all peak temperatures are reached in the brake.

Stops 5, 20, 23, 33, and 35, shall be conducted using cooling fans during and after the stop.

It shall be demonstrated before each stop that the brake is free to rotate.

The 45 normal energy stops shall be conducted on one set of friction material.

1.1.3 Results

The 45 stops were conducted with the following average results:

Number of Stops	-	45
KE	-	12.01×10^6 ft-lbs
IE	-	18273 lbs.
Landing Velocity	-	140.3
Average Stop Time	-	22.05 seconds

1.1.4 Substantiating Data

Brake Test Logs - Pages A-1 through A-7, Appendix
Wear Data Sheets-- Pages A-11 through A-14, Appendix
Torque, Pressure vs Time Curves - Pages A-19 through
Cooling Profile Curves - A-42, Appendix

IV. RESULTS

1. Dynamic Brake Tests (continued)

1.2 Peak Torque Surveys

1.2.1 Specification Reference

LTV Specification Document 204-16-37d, Para. 4.3.1.10
BFG ER-2731, Revision "E", Para. 1.4.2.1.1.1

1.2.2 Requirements

During the course of the 45 normal stop test, the torque development capabilities of the brake shall be determined by conducting maximum pressure stops from speeds of 10, 20, 40, 60, and 100 mph. Tests shall be conducted on both a hot and cold brake at worn conditions. This will also be conducted on a new brake.

1.2.3 Results

Tests were conducted as specified on both a new brake and a worn brake.

1.2.4 Substantiating Data

Peak Torque vs Time Curves - Pages A-15 through A-18, Appendix

1.3 Static Torque Test

1.3.1 Specification Reference

MIL-W-5013G, Paragraph 4.5.11
BFG ER-2731, Revision "E", Para. 1.4.2.1.1.2

1.3.2 Requirements

The pressure required to develop a static torque of 113,000 in-lbs, shall be determined during the 45 stop test. The test shall be conducted on the brake as follows:

IV. RESULTS

1. Dynamic Brake Tests (continued)

1.3 Static Torque Test (continued)

1.3.2 Requirements (continued)

1.3.2.1 While at room temperature (approximately 70°F).

1.3.2.2 With brake heated by normal energy stop, the test to be conducted as soon as is practical after the stop.

1.3.3 Results

Test was conducted as required. Results are shown on static torque log sheet, Appendix.

1.3.4 Substantiating Data

Static Torque Test Log, Page A-10, Appendix

1.4 Overload Energy Stops

1.4.1 Specification Reference

MIL-W-5013G, Paragraph 4.5.11 and Table 1.
BFG ER-2731, Revision "E", Paragraph 1.4.2.1.2

1.4.2 Requirements

Five (5) overload energy stops shall be conducted to the conditions of Table 1, using the same friction materials as were used for the normal energy stops.

After overload energy stop number 3 and 4, (test stops 48 and 49) no cooling shall be used until all peak temperatures are reached in the brake and in the beadseat. Temperature recordings shall be continued until the hottest portion of the brake has cooled to 300°F.

IV. RESULTS

1. Dynamic Brake Tests (continued)

1.4 Overload Energy Stops (continued)

1.4.3 Results

The five (5) overload stops were conducted with the following average results:

Number of Stops	- 5
KE	- 13.78 x 10^6 ft-lbs
IE	- 16928 pounds
Landing Velocity	- 156.1 mph
Average Stop Time	- 25.0 seconds

1.4.4 Substantiating Data

Brake Test Log - Page A-8, Appendix
Torque Pressure vs Time Curves - Pages A-43 through
Cooling Profile Curves - A-62, Appendix

1.5 RTO Stops

1.5.1 Specification Reference

MIL-W-5013G, Paragraph 4.5.11 and Table 1
LTV Specification Document 204-16-37d, Para. 3.4.14.2
BFG ER-2731, Revision "E", Para. 1.4.2.1.3

1.5.2 Requirements

The 2.135 x 10^6 stop and the 18.09 x 10^6 stop described in Table 1, comprise the RTO energy condition for the brake. The brake shall have new friction materials for this test.

The 2.135 x 10^6 stop shall be conducted first and the 18.09 x 10^6 stop shall be conducted as soon as the dynamometer has achieved the required velocity. This time is not to exceed five (5) minutes.

Fans will not be used until fuse plugs have blown.

This test shall be conducted on both a new brake and a fully worn brake.

IV. RESULTS

1. Dynamic Brake Tests (continued)

1.5 RTO Stops (continued)

1.5.3 Results

The test was conducted with the following results:

New Brake

	RTO 1	RTO 2
KE	- 2.135×10^6 ft-lbs	18.09×10^6 ft-lbs
IE	- 18311	18311
Landing Velocity	- 60.4 mph	171.8 mph
Stop Time	- 9.7 seconds	26.0 seconds

Worn Brake

	RTO 1	RTO 2
KE	- 2.209×10^6 ft-lbs	17.82×10^6 ft-lbs
IE	- 18311	18311
Landing Velocity	- 60.1 mph	170.7 mph
Stop Time	- 14.4 seconds	43.1 seconds

1.5.4 Substantiating Data

Brake Test Logs, Pages A-8 and A-9, Appendix

1.6 Turn-Around Capability

1.6.1 Specification Reference

BFG ER-2731, Revision "E", Paragraph 1.4.2.1.4

1.6.2 Requirements

The brake, with new friction materials, shall be subjected to the test spectrum of Table 2, three (3) times. The brake shall be cooled to ambient temperature between sequences.

After the three (3) sequences of Table 2 are performed, the sequence of Table 3 shall be conducted.

IV. RESULTS

1. Dynamic Brake Tests (continued)

1.6 Turn-Around Capability (continued)

1.6.2 Requirements (continued)

The energy absorbed by the brake during the 15 minute taxi period shall be simulated by three (3) brake stops to the conditions shown in Table 4 for the sequence shown in Table 3, and to the condition shown in Table 5 for the sequence shown in Table 2. The deceleration for the taxi stops in Table 2 will be 8 fps^2 and 6 fps^2 for Table 3.

TABLE 2

Maneuver	Total Elapsed Time	KE (ft-lbs)	IE (lbs)	Decel. Rate (ft/sec/sec)
* Taxi	15 min.	2.135×10^6	15630	
Fly	25 min.			
Land		11.95×10^6	15630	10
* Taxi	15 min.	2.135×10^6	15630	
Park	30 min.			
* Taxi	15 min.	2.135×10^6	15630	
Fly	25 min.			
Land		11.95×10^6	15630	10
* Taxi	15 min.	2.135×10^6	15630	
Park	30 min.			

Wheel beadseat temperature shall not exceed 350° F and fusible plugs shall remain intact.

NOTE: *Taxi Requirements

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IV. RESULTS

1. Dynamic Brake Tests (continued)

1.6 Turn-Around Capability (continued)

TABLE 3

Maneuver	Total Elapsed Time	KE (ft-lbs)	IE (lbs)	Decel. Rate (ft/sec/sec)
* Taxi	15 min.	2.135×10^6	18311	
Fly	25 min.			
Land		11.95×10^6	18311	8.5
* Taxi	15 min.	2.135×10^6	18311	
Park	30 min.			
* Taxi	15 min.	2.135×10^6	18311	
RTO		14.4×10^6	18311	10

*Taxi Requirements

Cooling fans may be used during taxi to simulate 30 knot wind speed and during parking to simulate an 8 knot wind.

TABLE 4
Taxi Requirements

Stops Required	Total Elapsed Time	IE (lbs)	Landing Velocity - mph	KE ft-lbs $\times 10^6$
1	3 min.	18311	32.4	.6402
1	8 min.	18311	32.4	.6402
1	15 min.	18311	37.4	.8552

TABLE 5
Taxi Requirements

Stops Required	Total Elapsed Time	IE (lbs)	Landing Velocity - mph	KE ft-lbs $\times 10^6$
1	3 min.	15630	35	.6402
1	8 min.	15630	35	.6402
1	15 min.	15630	40.5	.8552

IV. RESULTS

1. Dynamic Brake Tests (continued)

1.6 Turn-Around Capability (continued)

1.6.3 Results

The test was conducted as specified. Results are shown in graphic form on Pages A-78 through A-89, Appendix.

1.6.4 Substantiating Data

Cooling Profiles, Pages A-78 through A-89, Appendix.

1.7 Structural Torque

1.7.1 Specification Reference

MIL-W-5013G, Paragraph 4.5.12
LTV Specification Document 204-16-37d, Para. 3.3.10
BFG ER-2731, Revision "E", Para. 1.4.2.1.1.3

1.7.2 Requirements

With the brake actuated by maximum operating pressure of 1000 psi, the wheel and brake shall withstand a structural torque of 250,000 in-lbs without failure. The load shall be applied by means of a belt wrapped around the periphery of the tire. If slippage occurs, the friction surfaces of the brake shall be pinned or welded. This test shall be performed after the turn-around tests of Paragraph 1.6.

1.7.3 Results

Test was conducted as specified. A structural torque of 250,200 in-lbs was pulled with no failure to the brake or wheel assembly.

1.7.4 Substantiating Data

Structural Test Log, Page A-77, Appendix.

IV. RESULTS

2. Static Brake Tests

2.1 Endurance Test

2.1.1 Specification Reference

MIL-W-5013G, Paragraph 4.5.15
BFG ER-2731, Revision "E", Para. 1.4.2.2.2

2.1.2 Requirements

The brake actuation device, using simulated piston loads in lieu of friction materials, shall be required to withstand 100,000 cycles of application and release of normal operating pressures (as defined by MIL-W-5013G, Paragraph 6.3.2) and 5000 cycles at the maximum operating pressure of 1000 psi. The 100,000 cycle portion of this test shall be divided into portions of 25,000 cycles each with piston loads adjusted to simulate 25, 50, 75, and 100 percent worn conditions respectively, for the four 25,000 cycle portions.

There shall be no leakage or failure during or upon completion of this test.

Before and after the endurance test, pressure required to bring the braking surfaces into initial contact shall be observed and recorded. The minimum pressure at which braking surfaces disengage upon release of pressure shall also be noted and recorded. This test shall be conducted with the brake mounted on the torque flange of a horizontal axle, with the wheel assembly installed.

2.1.3 Results

The test was conducted with results shown on the endurange test log, Appendix.

2.1.4 Substantiating Data

Endurance Test Log, Pages A-73 and A-74, Appendix

IV. RESULTS

2. Static Brake Tests (continued)

2.2 Extreme Temperature Test

2.2.1 Specification Reference

MIL-W-5013G, Paragraph 4.5.16.1 and 4.5.16.2
BFG ER-2731, Revision "E", Para. 1.4.2.2.4.1 and 1.4.2.2.4.2

2.2.2 Requirements

The brake, filled with operating fluid, shall be subjected to a temperature of 160°F in a thermostatically controlled oven for a period of 168 hours with an applied pressure equal to normal operating pressure. Immediately upon removal from the oven and while still at elevated temperature, the brake shall be cycled 1000 times at normal operating pressure, followed by 25 cycles at maximum operating pressure. Leakage at static seals shall not exceed a trace, and leakage at dynamic seals shall not exceed one drop of fluid per each 3 inches of peripheral seal length.

Upon completion of the aging and heat test, the brake filled with operating fluid at atmospheric pressure shall be subjected to a temperature of -65°F for a period of 72 hours. (See Figure 2) There shall be no leakage during this period. At the expiration of the 72 hours, the brake with fluid entering at a temperature of -65°F shall be cycled 25 times at normal operating pressure, followed by 5 cycles at maximum operating pressure. Leakage shall be limited as above. Brake clearance shall be checked between each cycle to insure complete brake release. The time required for complete brake release shall be observed and recorded.

2.2.3 Results

Test was conducted to the conditions shown on Page A-75, Appendix.

IV. RESULTS

2. Static Brake Tests (continued)

2.2 Extreme Temperature Test (continued)

2.2.4 Substantiating Data

Extreme Temperature Test Log, Page A-75, Appendix.

2.3 Leakage Tests

2.3.1 Specification Reference

MIL-W-5013G, Paragraphs 4.5.13.1 and 4.5.13.2
BFG ER-2731, Revision "E", Paragraphs 1.4.2.2.5.1 and 1.4.2.2.5.2

2.3.2 Requirements

After completion of the cold test, the brake shall be parked for a period of 5 minutes with an applied pressure of 1500 psi (one and one-half times the maximum operating pressure). The brake shall then be parked for 5 minutes with an applied pressure of 5 psi. There shall be no measurable leakage or permanent set during these tests.

The brake shall be cycled 25 times at maximum operating pressure (1000 psi). Leakage at static seals shall not exceed a trace. Leakage at moving seals shall not exceed one drop of fluid per each 3 inches of peripheral seal length.

2.3.3 Results

The tests were conducted as required. There was no leakage or permanent set.

2.3.4 Substantiating Data

Hydraulic Pressure Test Log, Page A-76, Appendix.

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IV. RESULTS

2. Static Brake Tests (continued)

2.4 Static Pressure Test

2.4.1 Specification Reference

MIL-W-5013G, Paragraph 4.5.14
BFG ER-2731, Revision "E", Paragraph 1.4.2.2.6

2.4.2 Requirements

The brake, with 100 percent worn linings, shall be parked for 5 minutes at twice maximum operating pressure (2 x 1000 = 2000 psi). There shall be no leakage or failure. Pressure shall then be increased until failure occurs. Pressure at failure shall be recorded.

2.4.3 Results

There was no leakage when pressure of 2000 psi was applied to the brake for 5 minutes.

Pressure was increased to 3170 psi before failure occurred.

2.4.4 Substantiating Data

Hydraulic Pressure Test Log, Page A-76, Appendix.

2.5 Salt Test

2.5.1 Specification Reference

BFG ER-2731, Revision "E", Paragraph 1.4.1.6

2.5.2 Requirements

The brake shall undergo the salt spray test of MIL-STD-810A, Method 509.1, Procedure I.

2.5.3 Results

The test was conducted as required. There was no detrimental effects on the brake.

2.5.4 Substantiating Data

Test Log, Page A-90, Appendix

V. CONCLUSION

The B.F.Goodrich Part Number 2-1162-3 Brake Assembly does meet the intent and the requirements of the applicable specification documents and therefore is qualified.

B.F.GOODRICH AEROSPACE & DEFENSE PRODUCTS
Wheel and Brake Plant
Troy, Ohio

BRAKE TEST NO. Q-6031

Date started --
Date completed --

Aircraft A7D Specification MIL-W-5013G Project No.

Subject Qualification

CONFIGURATION

BRAKE
- Assembly No. 2-1162-3
- Size 12 x 4
- S/N L245
- TOTAL WT.
  - Before Test 106.0 lbs
  - After Test 95.3 lbs
- Fluid MIL-H-5606

WHEEL
- Assembly No. 3-1293-1
- Size 28 x 9.0-14
- S/N L345
- Weight lbs

TIRE
- Make As Noted
- Size 28 x 9.0-14
- Ply 22 PR Type VIII
- S/N As Noted

EP63

TEST CONDITIONS

DYNAMOMETER: 24"- 48"- 84"- 120" Right arm

Inertia		Gear Ratio	No. of Plates
Normal	18273	--	L - R -
Overload	16928	--	L - R -
RTO	18311	--	L - R -

Kinetic Energy		Initial Speed: MPH - RPM	
Normal	12.01 x 10^6 lb ft	Normal	140.3
Overload	13.95 x 10^6 lb ft	Overload	156.9
RTO	2.13 & 18.09 x 10^6 lb ft	RTO	59 & 171.6

Reqd. Stop Time		Reqd. Stop Distance	
Normal	22.1 sec.	Normal	-- ft
Overload	23.0 sec.	Overload	-- ft
RTO	8.7 & 25.2 sec.	RTO	-- ft

Brake Pressure		Rolling Radius	
Back	100 psi	Normal	11.9 in
Normal	-- psi	Overload	11.9 in
Max.	1000 psi	RTO	11.9 in
Inflation Press.	- psi	Offset Axle	8 in

Wheel Load		Required No. of Stops	
Normal	18100 lbs	Normal	45
Overload	18100 lbs	Overload	5
RTO	18100 lbs	RTO	2

Brake Measurements:
before test and after stops 45 & 50

Brake Clearance:
before test and after stops 9, 18, 27, 36

Fluid Displacement:
before test and after stops 10, 45, 50

Hot static torque after stops 4, 23, 41

Cold static torque after stops 4, 23, 41

TEST INSTRUMENTATION

OSCILLOGRAPH: Model 621 size 6 in

Required parameters (Peak Torques)
1. Torque
2. Pressure
3. Road wheel rev.
4. Test wheel revs.
5.
6.
7.
8.
9.
10.
11.
12.
13.
14.

TAPE RECORDER

Required parameters
1. Road wheel vel.
2. Test wheel vel.
3. Torque
4. Pressure
5. #1 Stator
6. #2 Rotor
7.
8.
9.
10.
11.
12.
13.
14.

THERMOCOUPLE LOCATION - BROWN RECORDER
1. Center Stator
2. Piston Housing
3. Torque Plate
4. False Axle
5. Bead Seat
6. Tubewell
7. Fuse Plug
8. Fluid
9. #2 Rotor
10. Pressure Plate

OTHER INSTRUMENTATION

B.F.GOODRICH AEROSPACE & DEFENSE PRODUCTS
Wheel and Brake Plant
Troy, Ohio

BRAKE TEST LOG

TEST NO. Q-6031

Sheet 1 of 8
Date 5-2-68

REQUIREMENTS: Wear-In Stops

LANDING VELOCITY As noted mph
STOP TIME As noted sec
STOP DISTANCE -- ft

PRESSURE: 140 psi back
-- psi min.
1000 psi max.

OTHER I. E. 18273 lbs.
84 inch Dynamometer

Stop No.	Log Time	Landing Velocity mph	Brake Press. psi	Stop Time sec	Stop Distance ft	TORQUE Avg. lb ft	TORQUE Peak lb ft	TEMPERATURES °F Center Stator Initial	Center Stator Peak	Piston Housing Initial	Piston Housing Peak	Torque Plate Initial	Torque Plate Peak	* OTHER PEAK TEMPERATURES °F 4	5	6	7	8	9	10	Notes
														FA	BS	TW	FP	F	$R_{\#2}$	PP	
								Wear-In Stops													
																					(1)(2)(3)
A	2052	40	300	14.8		1680	1920	78	288	78	92	78	150	100	100	99	95	94	198	131	
B	2213	60	350	16.7		2520	3510	100	495	82	102	98	223	115	115	120	110	108	418	192	
C	0025	80	400	22.0		3120	3840	95	882	84	116	88	317	134	127	147	123	120	520	300	5-3-68
D	0254	100	450	25.6		3390	4080	95	833	84	126	92	435	166	168	224	150	142	705	435	

REMARKS * FA - False Axle, BS - Bead Seat, TW - Tube Well, FP - Fuse Plug, F - Fluid, R - Rotor, PP - Pressure Plate.
(1) New brake clearance .101 in. (2) New brake displacement at 1000 psi pressure 1.71 in^3.
(3) Brake measurements.

EP355

B.F.GOODRICH AEROSPACE & DEFENSE PRODUCTS
Wheel and Brake Plant
Troy, Ohio

BRAKE TEST LOG

TEST NO. Q-6031

Sheet 2 of 8
Date 5-3-68

REQUIREMENTS: Normal Energy Stops

LANDING VELOCITY 140.3 mph
STOP TIME 22.1 sec
STOP DISTANCE -- ft

PRESSURE: 140 psi back
-- psi min.
1000 psi max.

OTHER I.E. 18273 lbs.
K.E. 12.01 x 10^6 ft.lbs.
84 inch Dynamometer

Stop No.	Log Time	Landing Velocity mph	Brake Press. psi	Stop Time sec	Stop Distance ft	TORQUE Avg. lb ft	TORQUE Peak lb ft	TEMPERATURES °F Center Stator Initial	Center Stator Peak	Piston Housing Initial	Piston Housing Peak	Torque Plate Initial	Torque Plate Peak	* OTHER PEAK TEMPERATURES °F 4 FA	5 BS	6 TW	7 FP	8 F	9 R #2	10 PP	Notes
						NORMAL ENERGY STOPS															
																					(1)
1	0659	140.5	700	23.4		6550	12070	82	1378	80	165	80	732	236	270	372	226	205	1172	702	
2	1037	140.5	727	20.5		7041	13440	81	1165	80	161	80	665	221	246	360	194	190	1152	682	
* 3	1354	140.3	712	22.3		6370	8691	100	1230	91	298	102	899	245	312	270	295	299	1260	700	(2)(3)
* 4	1705	140.9	710	22.4		6885	8880	80	1265	81	169	81	689	241	260	379	198	200	1228	701	
																					(4)
5	2130	140.0	724	21.9		6212	7670	80	1243	80	302	80	741	300	300	255	280	301	1495	800	(3)
																					(5)
6	0202	140.2	748	21.9		5630	8290	64	1170	74	182	74	576	152	179	270	126	194	1368	645	5-6-68
7	0727	140.3	734	21.5		6228	13430	65	1162	75	172	75	696	248	267	414	230	188	1338	633	
																					(6)
8	1515	139.2	729	21.4		6409	8600	65	1250	75	300	75	872	270	308	381	271	301	1450	908	(2)
9	1815	140.1	741	22.5		6406	7970	75	1268	77	188	78	680	209	240	339	180	203	1248	723	
																					(7)

REMARKS * FA - False Axle, BS - Bead Seat, TW - Tube Well, FP - Fuse Plug, F- Fluid, R - Rotor, PP - Pressure Plate. (1) Force to turn wheel 2 lbs. at tire O.D. (2) Hot Park (3) Temperature Profile. (4) Hot & Cold Torque. (5) Force to turn wheel 4 lbs. at tire O.D. (6) Changed tire. (7) Brake clearance .115 in.

EP355

B.F.GOODRICH AEROSPACE & DEFENSE PRODUCTS
Wheel and Brake Plant
Troy, Ohio

BRAKE TEST LOG

TEST NO. Q-6031

Sheet 3 of 3
Date 5-6-68

REQUIREMENTS: Normal Energy Stops

LANDING VELOCITY 140.3 mph
STOP TIME 22.1 sec
STOP DISTANCE -- ft

PRESSURE: 140 psi back
--- psi min.
1000 psi max.

OTHER I.E. 18273 lbs.
K.E. 12.01 x 10^6 ft.lbs.
84 inch Dynamometer

Stop No.	Log Time	Landing Velocity mph	Brake Press. psi	Stop Time sec	Stop Distance ft	TORQUE Avg. lb ft	TORQUE Peak lb ft	TEMPERATURES °F Center Stator Initial	Center Stator Peak	Piston Housing Initial	Piston Housing Peak	Torque Plate Initial	Torque Plate Peak	* OTHER PEAK TEMPERATURES °F 4 FA	5 BS	6 TW	7 FP	8 F	9 R #2	10 PP	Notes
10	2125	140.4	717	21.4		6160	7258	80	1216	78	176	78	670	211	260	358	190	193	1413	719	
11	0652	140.2	729	22.7		5933	7300.	62	1342	74	148	74	695	202	255	385	196	172	1135	702	(1)(2)(3) 5-7-68
12	1305	140.0	735	21.1		5852	6540	65	1212	78	171	78	669	199	241	358	188	190	(4)	701	
13	1610	140.5	721	22.7		5540	7300	88	1255	80	307	83	841	283	319	378	279	309	1154	925	(5)
14	1909	140.3	728	21.1		5946	7000	90	1227	80	179	83	701	212	264	384	204	195	1105	700	
15	2215	140.1	730	22.9		5540	6190	85	1302	81	170	83	729	211	258	362	203	185	1241	700	
16	0113	140.5	730	22.2		5110	6315	72	1234	80	160	80	740	(4)	255	366	200	175	1170	700	(1) 5-8-68
17	0427	140.2	730	22.5		5040	6060	70	1287	78	161	78	733	203	234	330	190	182	1052	695	
18	0734	140.2	730	21.6		6193	7414	75	1224	80	295	80	778	280	331	255	300	310	1242	879	(5)(6)(7)
19	1031	140.7	730	22.2		5070	6170	80	1260	80	159	80	769	219	270	379	211	173	1060	672	

REMARKS * FA - False Axle, BS - Bead Seat, TW - Tube Well, FP - Fuse Plug, F - Fluid, R - Rotor, PP - Pressure Plate. (1) Force to turn wheel 4 lbs. at tire O.D. (2) Fluid Displacement is 1.95 in^3. (3) Brake measurements. (4) No record. (5) Hot park. (6) Temperature profile. (7) Brake clearance .115 in.

EP355

B.F.GOODRICH AEROSPACE & DEFENSE PRODUCTS
Wheel and Brake Plant
Troy, Ohio

BRAKE TEST LOG TEST NO. Q-6031 Sheet 4 of 8
Date 5-8-68

REQUIREMENTS: Normal Energy Stops

LANDING VELOCITY 140.3 mph
STOP TIME 22.1 sec
STOP DISTANCE -- ft

PRESSURE: 140 psi back
-- psi min.
1000 psi max.

OTHER I.E. 18273 lbs.
K.E. 12.01 x 10^6 ft.lb.
84 inch Dynamometer

Stop No.	Log Time	Landing Velocity mph	Brake Press. psi	Stop Time sec	Stop Distance ft	TORQUE Avg. lb ft	TORQUE Peak lb ft	TEMPERATURES °F Center Stator Initial	Center Stator Peak	Piston Housing Initial	Piston Housing Peak	Torque Plate Initial	Torque Plate Peak	* OTHER PEAK TEMPERATURES °F 4 FA	5 BS	6 TW	7 FP	8 F	9 $R_{\#2}$	10 PP	Notes
20	1325	140.4	730	21.9		5510	6303	90	1200	81	165	81	750	213	252	239	200	189	1210	683	
																					(1)
21	0442	140.2	735	22.8		4862	6620	70	1334	80	164	80	742	214	272	295	215	190	1402	675	5-9-68
																					(2)
22	0736	140.1	731	22.2		4930	5840	88	1253	82	176	82	735	222	272	299	217	196	1428	722	
23	1019	140.5	726	21.6		4673	5700	85	1309	81	160	81	891	230	280	329	222	189	1215	841	
																					(3)
24	1337	140.5	732	22.7		5502	6560	80	1270	80	302	80	933	283	331	360	310	310	1378	860'	
25	1640	140.2	740	22.7		5526	6580	85	298*	82	153	83	700	207	277	309	219	176	(4)	673	
																					(5)
26	2040	140.4	756	23.0		5683	6850	90	1305	83	179	85	727	209	281	324	213	200	1183	709	
27	0020	140.1	764	21.6		5580	6480	85	1279	82	145	82	692	198	263	294	206	168	1192	662	5-10-68
28	0427	140.1	754	21.6		6223	7230	80	1298	80	310	80	922	280	333	358	314	324	1194	864	
																					(6)
29	0717	140.2	758	22.9		6068	6860	80	1295	80	142	80	707	195	256	304	195	170	1202	680	
																					(7)

REMARKS * FA - False Axle, BS - Bead Seat, TW - Tube Well, FP - Fuse Plug, F - Fluid, R - Rotor, PP - Pressure Plate. (1) Brake measurements. (2) Force to turn wheel 3 lbs. at tire O.D. (3) Hot and cold static torque. (4) No record. (5) Force to turn wheel 4 lbs. at tire O.D. (6) Hot park. (7) Force to turn wheel 2 lbs. at tire O.D.

EP355

B.F.GOODRICH AEROSPACE & DEFENSE PRODUCTS
Wheel and Brake Plant
Troy, Ohio

BRAKE TEST LOG

TEST NO. Q-6031

Sheet 5 of 8
Date 5-10-68

REQUIREMENTS:

LANDING VELOCITY 140.3 mph
STOP TIME 22.1 sec
STOP DISTANCE -- ft

PRESSURE: 140 psi back
-- psi min.
1000 psi max.

OTHER I.E. 18273 lbs.
K.E. 12.01 x 10^6 ft.lbs.
84 inch Dynamometer

Stop No.	Log Time	Landing Velocity mph	Brake Press. psi	Stop Time sec	Stop Distance ft	TORQUE Avg. lb ft	TORQUE Peak lb ft	TEMPERATURES °F Center Stator Initial	Center Stator Peak	Piston Housing Initial	Piston Housing Peak	Torque Plate Initial	Torque Plate Peak	* OTHER PEAK TEMPERATURES °F 4 FA	5 BS	6 TW	7 FP	8 F	9 R #2	10 PP	Notes
30	0938	140.9	746	22.9		5526	6270	80	1292	80	149	80	759	200	268	310	(1)	170	1175	669	(2)(3)
31	2318	139.4	825	22.8		5475	6140	68	1422	80	147	80	737	210	263	301	(1)	167	1310	660	
32	0500	140.1	825	21.8		5361	6460	70	1295	80	150	80	692	205	259	306	(1)	168	1400	713	5-11-68
33	1737	140.2	805	21.9		5531	6010	75	1302	82	291	82	927	320	373	314	344	295	1212	890	(4)(5)(6)
34	2155	140.4	790	21.7		5480	6390	80	1247	82	139	82	751	278	308	221	278	164	1365	690	(7)
35	0846	140.1	804	21.2		5811	6610	70	1280	81	135	81	704	214	302	212	262	166	1231	674	5-12-68 (5)(8)
36	1851	140.2	800	21.4		5856	6900	70	1260	80	154	80	770	220	305	220	279	171	1204	698	(9)(7)
37	2208	140.3	824	21.5		5977	6950	80	1260	80	141	80	737	220	304	220	279	166	1175	690	(10)
38	0125	140.2	793	21.7		5483	6460	83	1318	80	298	80	935	298	369	315	336	307	1200	904	5-13-68 (4)(5)(8)

* FA - False Axle, BS - Bead Seat, TW - Tube Well, FP - Fuse Plug, F - Fluid, R - Rotor, PP - Pressure Plate. (1) No record. (2) Brake clearance .115 in. (3) Brake measurements. (4) Hot park. (5) Temperature profile. (6) Force to turn wheel 6 lbs. at tire O.D. (7) Force to turn wheel 10 lbs.

REMARKS at tire O.D. (8) Force to turn wheel 8 lbs. at tire O.D. (9) Brake clearance .135 in.
(10) Force to turn wheel 9 lbs. at tire O.D.

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B.F.GOODRICH AEROSPACE & DEFENSE PRODUCTS
Wheel and Brake Plant
Troy, Ohio

BRAKE TEST LOG

TEST NO. Q-6031

Sheet 6 of 8

Date 5-13-68

REQUIREMENTS:

LANDING VELOCITY 140.3 mph
STOP TIME 22.1 sec
STOP DISTANCE -- ft

PRESSURE: 140 psi back
-- psi min.
1000 psi max.

OTHER I.E. 18273 lbs.
K.E. 12.01 x 10^6 ft.lb.
84 inch Dynamometer

Stop No.	Log Time	Landing Velocity mph	Brake Press. psi	Stop Time sec	Stop Distance ft	TORQUE Avg. lb ft	TORQUE Peak lb ft	TEMPERATURES °F Center Stator Initial	Center Stator Peak	Piston Housing Initial	Piston Housing Peak	Torque Plate Initial	Torque Plate Peak	* OTHER PEAK TEMPERATURES °F 4 FA	5 BS	6 TW	7 FP	8 F	9 $R_{\#2}$	10 PP	Notes
39	0437	140.1	802	21.5		5837	6150	75	1300	80	134	80	747	215	319	216	279	155	1140	685	
40	0732	140.1	790	22.4		5639	6310	90	1295	80	137	80	774	218	319	220	276	162	1200	700	(1)(2)
41	2140	140.4	806	22.0		5680	6650	75	1383	80	295	80	921	229	319	230	285	270	1385	783	(3)
42	0116	140.2	820	22.6		5720	6890	80	1358	82	155	82	820	225	316	220	285	178	(4)	728	5-14-68
43	0441	140.2	799	22.7		5530	6500	80	1360	80	275	80	998	275	349	288	315	280	(4)	918	(5)
44	0852	140.6	801	22.8		4916	5709	77	1345	81	160	81	824	231	329	232	282	182	1182	692	
45	1122	140.2	808	22.3		5030	6500	82	1311	82	161	81	782	219	329	219	198	185	1189	739	(6)(7)

REMARKS * FA - False Axle, BS - Bead Seat, TW - Tube Well, FP - Fuse Plug, F - Fluid, R - Rotor, PP - Pressure Plate. (1) Brake measurements. (2) Force to turn wheel 8 lbs. at tire O.D. (3) Hot and cold static torque. (4) No record. (5) Hot park. (6) Cold displacement at 1000 psi pressure 1.95 in^3. (7) Total brake weight with fluid and thermocouples 97.9 lbs.

EP355

34-919 O - 70 - 5

B.F.GOODRICH AEROSPACE & DEFENSE PRODUCTS
Wheel and Brake Plant
Troy, Ohio

BRAKE TEST LOG

TEST NO. Q-6031

Sheet 7 of 8
Date 5-22-68

REQUIREMENTS:

LANDING VELOCITY -- mph
STOP TIME -- sec
STOP DISTANCE -- ft

PRESSURE: 140 psi back
psi min.
1000 psi max.

OTHER

Stop No.	Log Time	Landing Velocity mph	Brake Press. psi	Stop Time sec	Stop Distance ft	TORQUE		TEMPERATURES °F						OTHER PEAK TEMPERATURES °F							Notes
						Avg. lb ft	Peak lb ft	Center Stator		Piston Housing		Torque Plate									
								Initial	Peak	Initial	Peak	Initial	Peak	4	5	6	7	8	9	10	
														FA	BS	TW	FP	F	R #2	PP	
46	1811	155.1	900	23.8		5335	6080	78	1535	80	201	80	948	184	259	192	182	228	1553	795	
47	2137	155.5	905	24.0		5129	6150	75	1508	82	264	82	1053	248	319	367	240	268	1498	882	
48	2341	156.3	950	24.9		5244	6510	92	1505	80	378	80	1151	372	338	422	405	394	1528	931	(2)
49	0442	157.0	965	26.1		5134	7210	75	1562	81	363	81	1146	391	361	463	399	372	1500	1012	
50	0739	156.8	950	26.3		4839	6420	75	1558	82	293	82	1102	210	266	210	191	280	1416	952	
						Worn Brake RTO															
																					(1)
RTO1	1623	60.1	600	14.4		4150	7500														
RTO2	1628	170.7	1000	43.1		3380	15570	338	2240	115	355	283	1610	482	580	673	438	350	2100	1418	(3)

REMARKS (1) 5-24-68 (2) Fuse plug blew approx. 25 min. after stop. (3) Fuse plugs blew 7 minutes after RTO No. 2.

EP355

B.F.GOODRICH AEROSPACE & DEFENSE PRODUCTS
Wheel and Brake Plant
Troy, Ohio

BRAKE TEST LOG

TEST NO. Q-6031

Sheet 8 of 8

Date

REQUIREMENTS:

LANDING VELOCITY -- mph

STOP TIME -- sec

STOP DISTANCE -- ft

PRESSURE: 140 psi back

psi min.

1000 psi max.

OTHER New Brake

Stop No.	Log Time	Landing Velocity mph	Brake Press. psi	Stop Time sec	Stop Distance ft	TORQUE		TEMPERATURES °F						OTHER PEAK TEMPERATURES °F							
						Avg. lb ft	Peak lb ft	Center Stator Initial	Center Stator Peak	Piston Housing Initial	Piston Housing Peak	Torque Plate Initial	Torque Plate Peak	4	5	6	7	8	9	10	
RTO 1	0004	60.4	700	9.7		5500	7250														
RTO 2	0009	171.8	1000	26.0		5600	6600	253	1806	115	453	153	1110	462	538	480	433	448	1941	1178	(1)

REMARKS (1) Fuse plug blew 12 minutes after RTO No. 2.

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B.F.GOODRICH AEROSPACE & DEFENSE PRODUCTS
Wheel and Brake Plant
Troy, Ohio

STATIC TORQUE

TEST NO. Q-6031

Sheet 1 of 1

Brake Assembly No. 2-1162-3

Lining No. ______

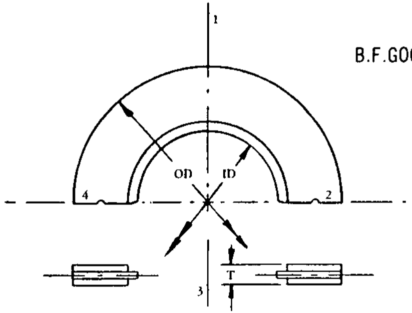
Lining Material ______

Disk No. ______

Disk Material ______

Date	After Stop No.	Amb. Temp. °F	Brake Temperature Hot °F	Brake Temperature Cold °F	Brake Pressure Hot psi	Brake Pressure Cold psi	Static Torque Hot lb ft	Static Torque Cold lb ft	REMARKS
5-3-68	4	82	1200		955		7490		Pressure at 89800 lb. in.
5-3-68	4	80		95		978		9417	Pressure at 113,000 lb. in.
5-9-68	23	80	1200		962		8520		Pressure at 102,240 lb. in.
5-9-68	23	80		100		967		9417	Pressure at 113,000 lb. in.
5-13-68	41	80	1200		1013		7410		Pressure at 88,920 lb. in.
5-13-68	41	80		100		1000		9417	Pressure at 113,000 lb. in.

EP66



B.F.GOODRICH AEROSPACE & DEFENSE PRODUCTS
Wheel and Brake Plant
Troy, Ohio

WEAR DATA

Disk _ x Lining

TEST NO. Q-6031

Sheet ______

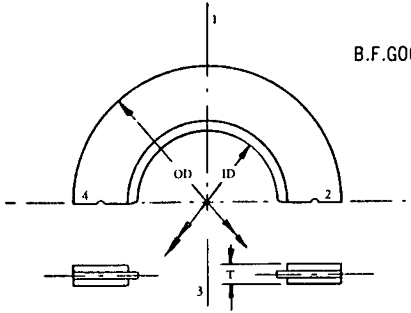
NOMENCLATURE

Disk Assy No. ______
Carrier No. ______
Segment No. ______
Friction Material ______

Carrier & Lining Assy No. 244-270
Carrier No. 261-268
Lining No. ES 16.32
Friction Material Iron Base

BRAKE LOCATION NO.	STOP COMPLETED	WT. LBS.	OD INS.	ID INS.	THICKNESS Position 1 in.	THICKNESS Position 2 in.	THICKNESS Position 3 in.	THICKNESS Position 4 in.	THICKNESS Avg. in.	WEAR Total ins.	WEAR Per Stop Per Surf. ins.	REMARKS
1	New	7.0	11.860	7.072	.444	.444	.444	.445	.444	--	--	
	10	6.8	11.847	7.050	.402	.417	.419	.405	.411	.033	.00165	
	20	6.5	11.822	7.018	.391	.408	.405	.406	.403	.041	.00102	
	30	6.1	11.781	6.947	.346	.343	.392	.394	.368	.076	.00121	
	40	5.5	11.745	6.916	.292	.367	.306	.278	.311	.133	.00166	
	45	5.4	11.710	6.896	.283	.326	.306	.278	.298	.298	.00162	
	50	5.1	11.705	6.433	.295	.266	.257	.296	.278	.166	.00166	
2	New	7.0	11.858	7.082	.445	.446	.445	.445	.445	--	--	
	10	6.9	11.845	7.048	.434	.430	.419	.425	.427	.018	.0009	
	20	6.6	11.825	7.032	.421	.413	.363	.370	.392	.053	.00132	
	30	6.4	11.815	6.998	.405	.397	.340	.372	.378	.067	.00111	
	40	5.7	11.760	6.962	.375	.376	.285	.363	.350	.095	.00118	
	45	5.5	11.726	6.930	.356	.265	.266	.360	.312	.133	.00147	
	50	5.2	11.700	6.460	.329	.312	.255	.258	.288	.157	.00157	
3	New	7.0	11.852	7.074	.445	.445	.445	.445	.445	--	--	
	10	6.9	11.849	7.066	.416	.407	.426	.423	.418	.027	.00135	
	20	6.6	11.832	7.040	.392	.367	.391	.409	.390	.055	.00137	
	30	6.2	11.822	7.010	.383	.350	.376	.402	.378	.067	.00111	
	40	5.6	11.750	6.926	.356	.255	.355	.368	.334	.111	.00138	
	45	5.5	11.690	6.875	.352	.251	.261	.359	.306	.139	.00154	
	50	5.1	11.670	6.457	.324	.258	.255	.317	.288	.157	.00157	

EP215



B.F.GOODRICH AEROSPACE & DEFENSE PRODUCTS
Wheel and Brake Plant
Troy, Ohio

WEAR DATA

Disk _ x Lining

TEST NO. Q-6031
Sheet ______

NOMENCLATURE

Disk Assy No. ______
Carrier No. ______
Segment No. ______
Friction Material ______

Carrier & Lining Assy No. 244-271
Carrier No. 261-256
Lining No. ES 16.32
Friction Material Iron Base

BRAKE LOCATION NO.	STOP COMPLETED	WT. LBS.	OD INS.	ID INS.	THICKNESS Position 1 in.	2 in.	3 in.	4 in.	Avg. in.	WEAR Total ins.	Per Stop Per Surf. ins.	REMARKS
PP	None	9.0	11.895	7.006	.544	.542	.540	.543	.542	--	--	Pressure Plate
	10	8.9	11.890	7.020	.536	.522	.520	.527	.526	.016	.00160	
	20	8.7	11.895	7.061	.528	.502	.500	.511	.510	.032	.00160	
	30	8.6	11.889	7.005	.520	.482	.480	.497	.495	.047	.00123	
	40	8.4	11.891	7.064	.513	.464	.461	.483	.480	.062	.00155	
	45	8.3	11.894	7.038	.510	.455	.452	.476	.473	.069	.00153	
	50	8.1	11.873	6.461	.438	.435	.482	.484	.460	.082	.00164	
TP	None	17.1										Torque Plate
	10	17.0										
	20	16.9										
	30	16.7										
	40	16.5										
	45	16.4										
	50	16.2										

EP215

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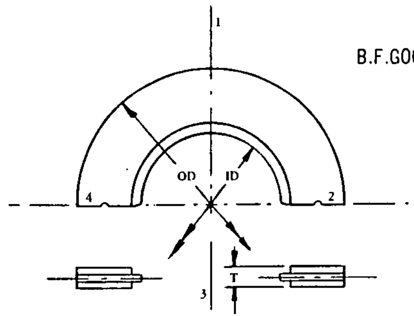


B.F.GOODRICH AEROSPACE & DEFENSE PRODUCTS
Wheel and Brake Plant
Troy, Ohio

WEAR DATA

TEST NO. Q-6031

Sheet ______

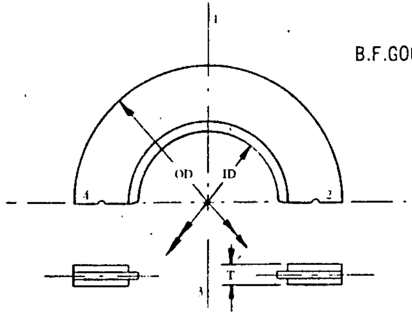
Disk x   _ Lining

NOMENCLATURE

Disk Assy No. 134-44	Carrier & Lining Assy No. ______
Carrier No. ______	Carrier No. ______
Segment No. 133-302	Lining No. ______
Friction Material ______	Friction Material ______

BRAKE LOCATION NO.	STOP COMPLETED	WT. LBS.	OD INS.	ID INS.	THICKNESS Position 1 in.	2 in.	3 in.	4 in.	Avg. in.	WEAR Total ins.	Per Stop Per Surf. ins.	REMARKS
1	New	10.6	11.902	7.115	.503	.503	.503	.503	.503	--	--	
	10	10.5	11.928	7.131	.504	.502	.499	.499	.501	.002	.000100	
	20	10.4	11.928	7.142	.503	.502	.501	.503	.502	.001	.000025	
	30	10.3	11.788	7.240	.496	.495	.490	.490	.493	.010	.000167	
	40	10.2	11.773	7.328	.489	.489	.488	.487	.488	.015	.000188	
	45	10.1	11.960	7.132	.488	.486	.487	.509	.492	.011	.000122	
	50											
2	New	10.6	11.935	7.122	.504	.504	.504	.504	.504	--	--	
	10	10.5	11.980	7.146	.503	.503	.500	.505	.503	.001	.000050	
	20	10.4	11.968	7.148	.497	.500	.495	.493	.496	.008	.000200	
	30	10.3	11.782	7.235	.495	.494	.493	.492	.494	.010	.000167	
	40	10.2	11.768	7.240	.490	.490	.488	.489	.489	.015	.000188	
	45	10.2	11.912	7.166	.511	.511	.510	.510	.510	--	--	
	50											

EP215



B.F.GOODRICH AEROSPACE & DEFENSE PRODUCTS
Wheel and Brake Plant
Troy, Ohio

WEAR DATA

TEST NO. Q-6031

Disk x _ Lining

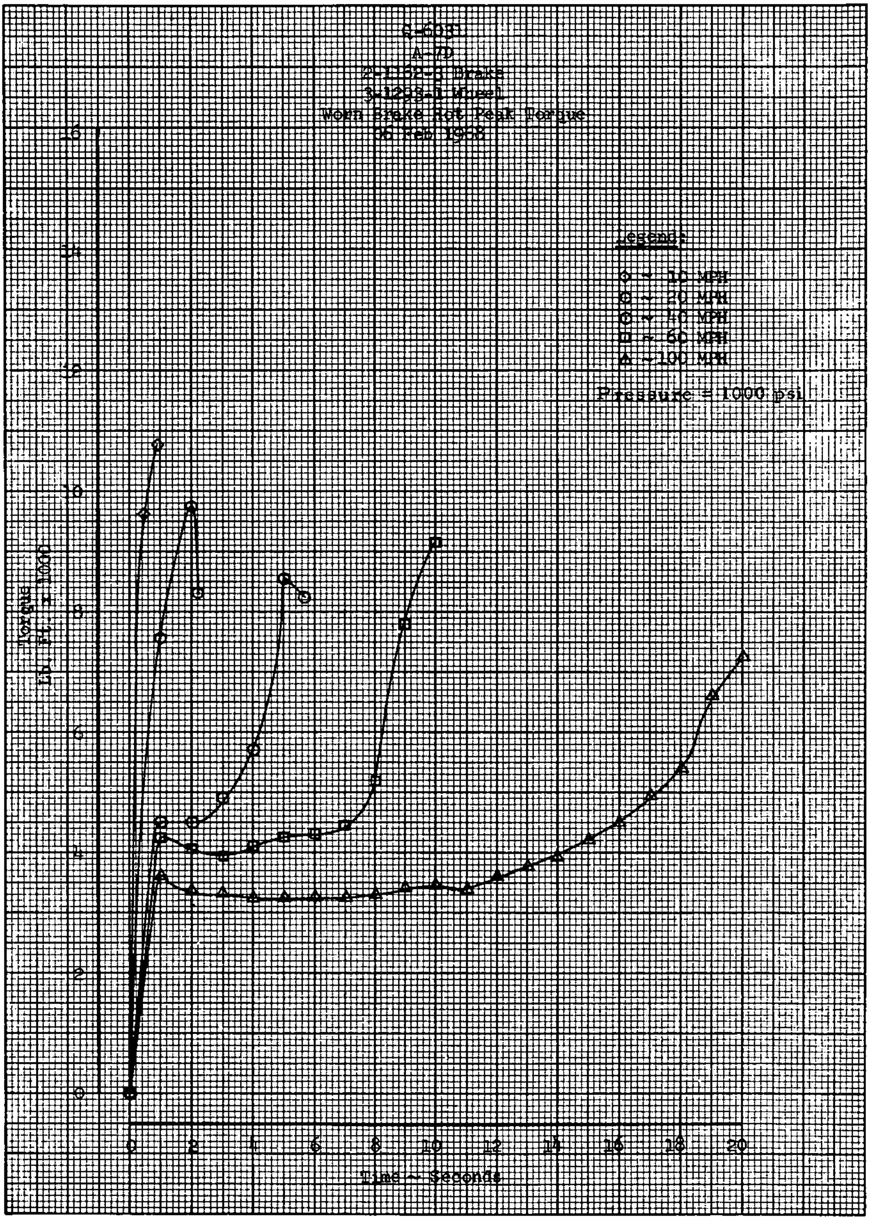
Sheet ______

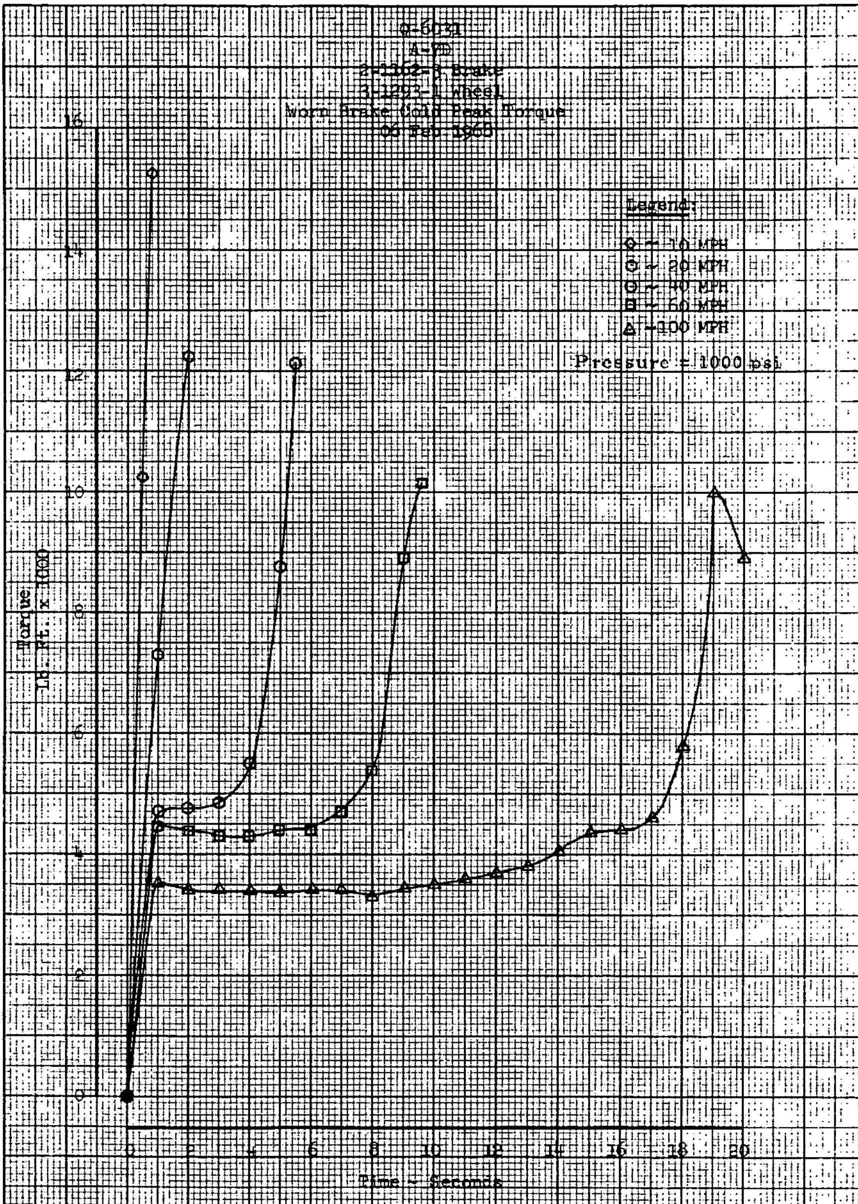
NOMENCLATURE

Disk Assy No. ______ Carrier & Lining Assy No. ______
Carrier No. ______ Carrier No. ______
Segment No. ______ Lining No. ______
Friction Material ______ Friction Material ______

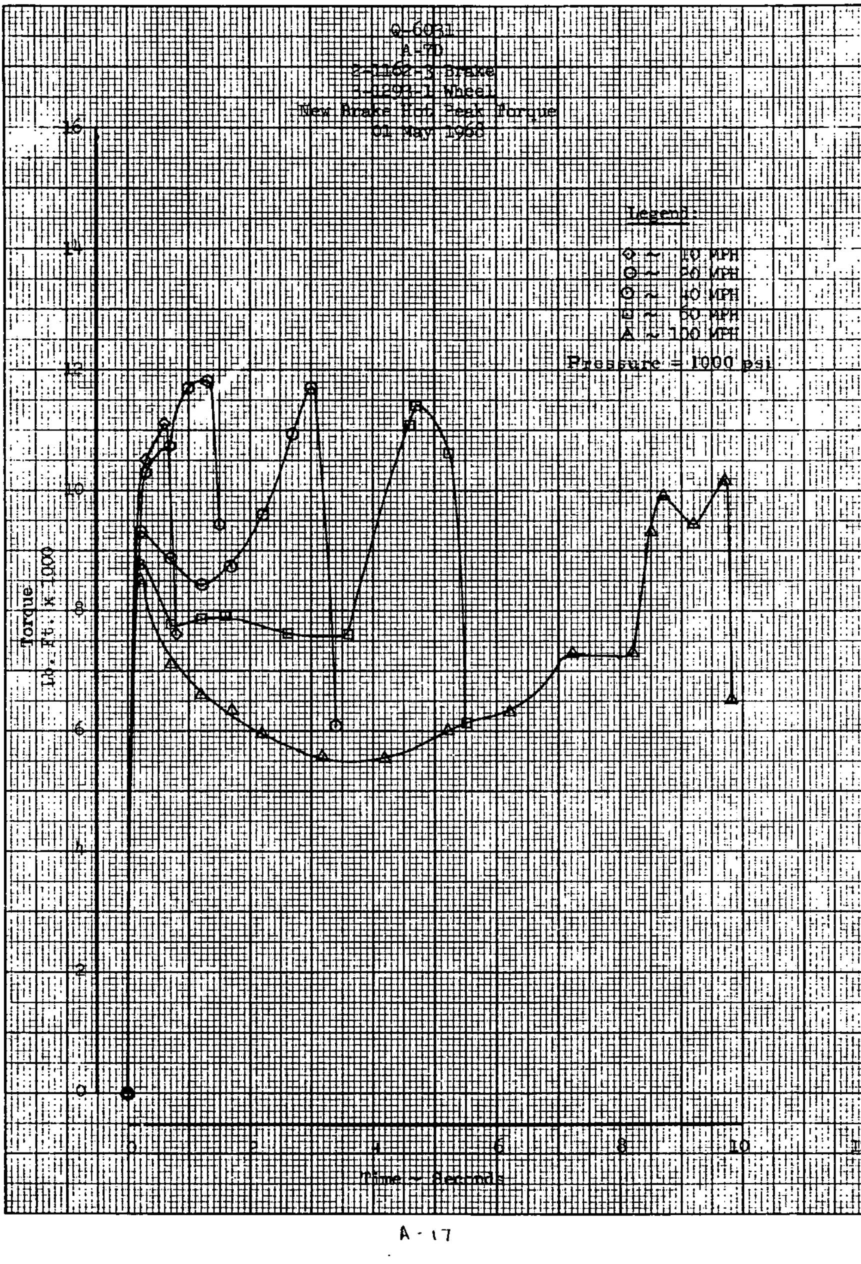
BRAKE LOCATION NO.	STOP COMPLETED	WT. LBS.	OD INS.	ID INS.	THICKNESS Position 1 in.	2 in.	3 in.	4 in.	Avg. in.	WEAR Total ins.	Per Stop Per Surf. ins.	REMARKS
3	New	10.6	11.922	7.113	.504	.504	.504	.504	.504	--	--	
	10	10.5	11.952	7.139	.498	.498	.499	.499	.498	.006	.000300	
	20	10.4	11.955	7.138	.498	.502	.495	.494	.497	.007	.000175	
	30	10.3	11.960	7.132	.486	.484	.486	.485	.485	.019	.000316	
	40	10.2	11.908	7.134	.486	.485	.484	.485	.485	.019	.000236	
	45	10.1	11.940	7.118	.507	.507	.506	.506	.506	--	--	
	50											
4	New	10.6	11.926	7.110	.504	.504	.503	.503	.504	--	--	
	10	10.5	11.938	7.142	.502	.501	.501	.502	.502	.002	.000100	
	20	10.4	11.958	7.142	.498	.497	.491	.498	.496	.008	.000200	
	30	10.2	11.782	7.210	.494	.492	.491	.493	.492	.012	.000200	
	40	10.1	11.799	7.168	.495	.490	.490	.491	.492	.012	.000150	
	45	10.1	11.938	7.122	.504	.504	.503	.504	.504	--	--	
	50											

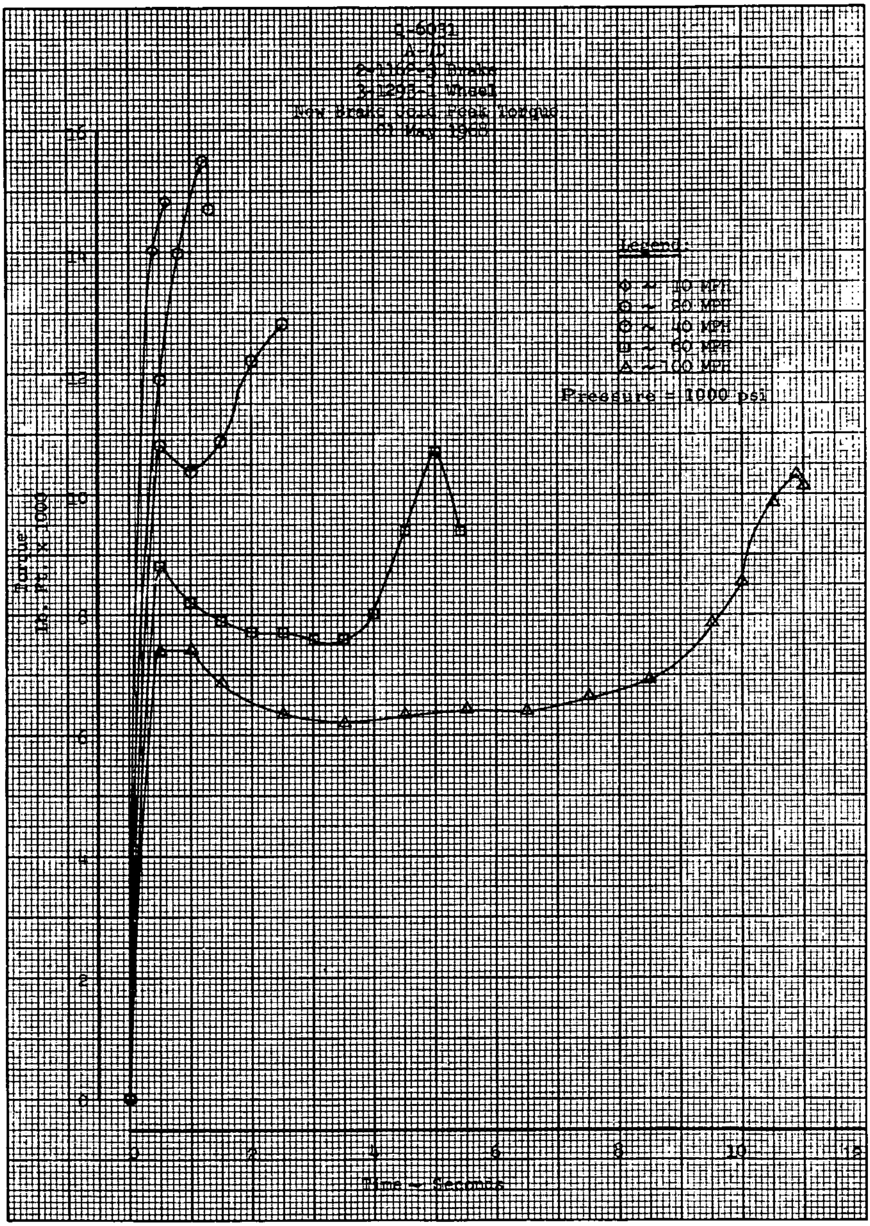
FP215

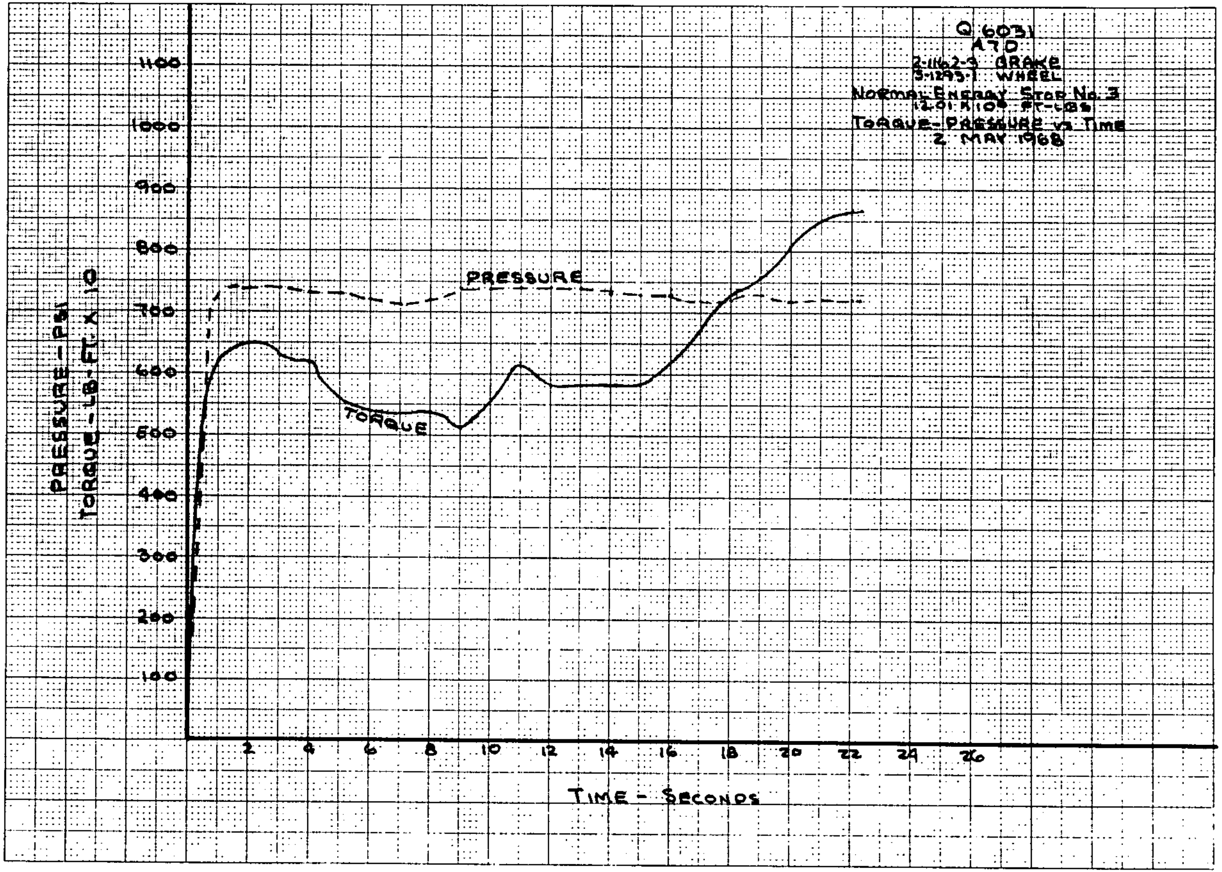

Q-6031
A-7D
2-1162-3 Brake
3-1293-1 Wheel
Worn Brake Hot Peak Torque
06 Feb 1968
Legend:
~ 10 MPH
~ 20 MPH
~ 40 MPH
~ 60 MPH
~100 MPH
Pressure = 1000 psi
Torque
Lb. Ft. x 1000
0
2
4
6
8
10
12
14
16
0
2
4
6
8
10
12
14
16
18
20
Time ~ Seconds


Q-6031
A-7D
Worn Brake Cold Peak Torque
Legend:
◇ ~ 10 MPH
⊙ ~ 20 MPH
⊖ ~ 40 MPH
□ ~ 60 MPH
△ ~ 100 MPH
Pressure = 1000 psi
Torque
Lb. Ft. x 1000
16
14
12
10
8
6
4
2
0
0
2
4
6
8
10
12
14
16
18
20
Time ~ Seconds

A 16

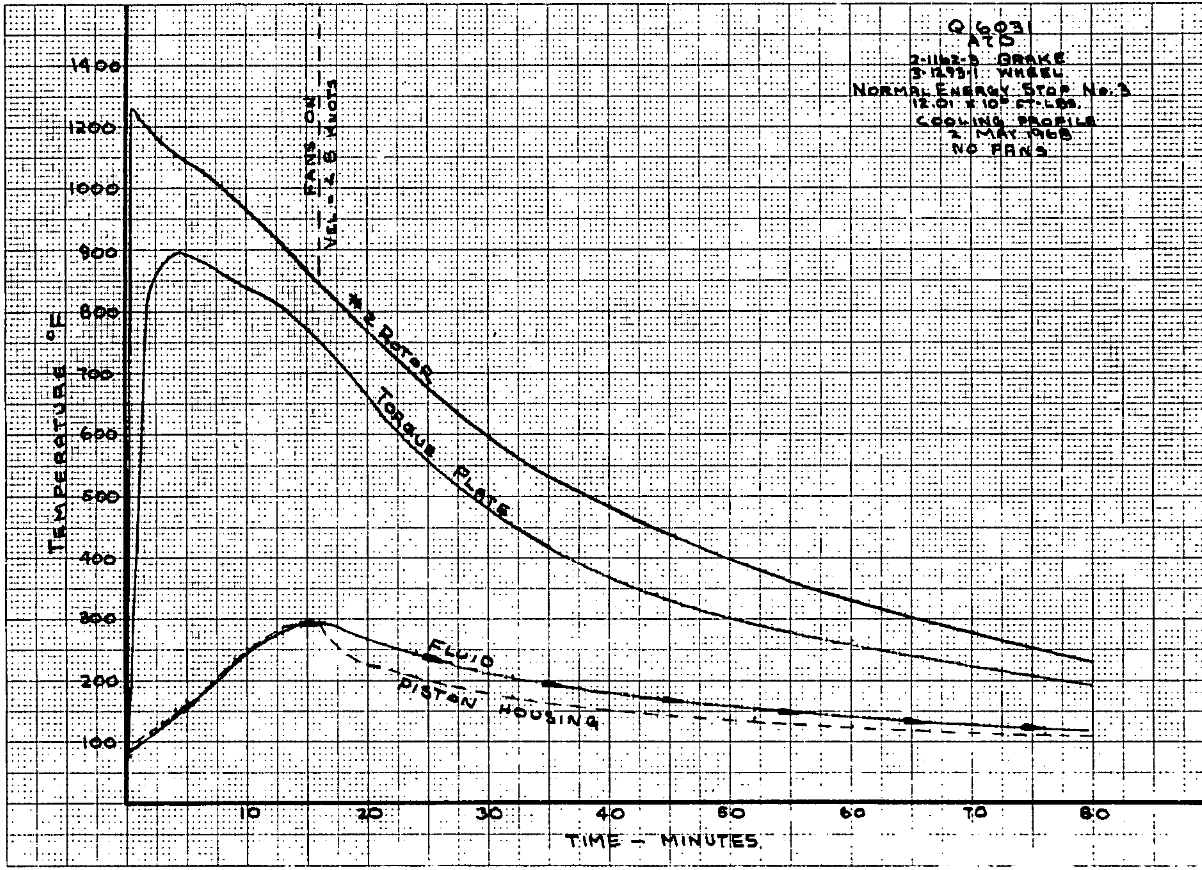

Q-6031
A-70
2-1162-3 Brake
3-1293-1 Wheel
New Brake Hot Peak Torque
01 May 1968
Legend:
◇ ~ 10 MPH
○ ~ 20 MPH
⊙ ~ 40 MPH
□ ~ 60 MPH
△ ~ 100 MPH
Pressure = 1000 psi
Torque
Lb. Ft. x 1000
16
14
12
10
8
6
4
2
0
0
2
4
6
8
10
12
Time ~ Seconds


Legend:
~ 10 MPH
~ 20 MPH
~ 40 MPH
~ 60 MPH
~ 100 MPH
Pressure = 1000 psi
Time ~ Seconds
16
14
12
10
8
6
4
2
0
0
2
4
6
8
10
12

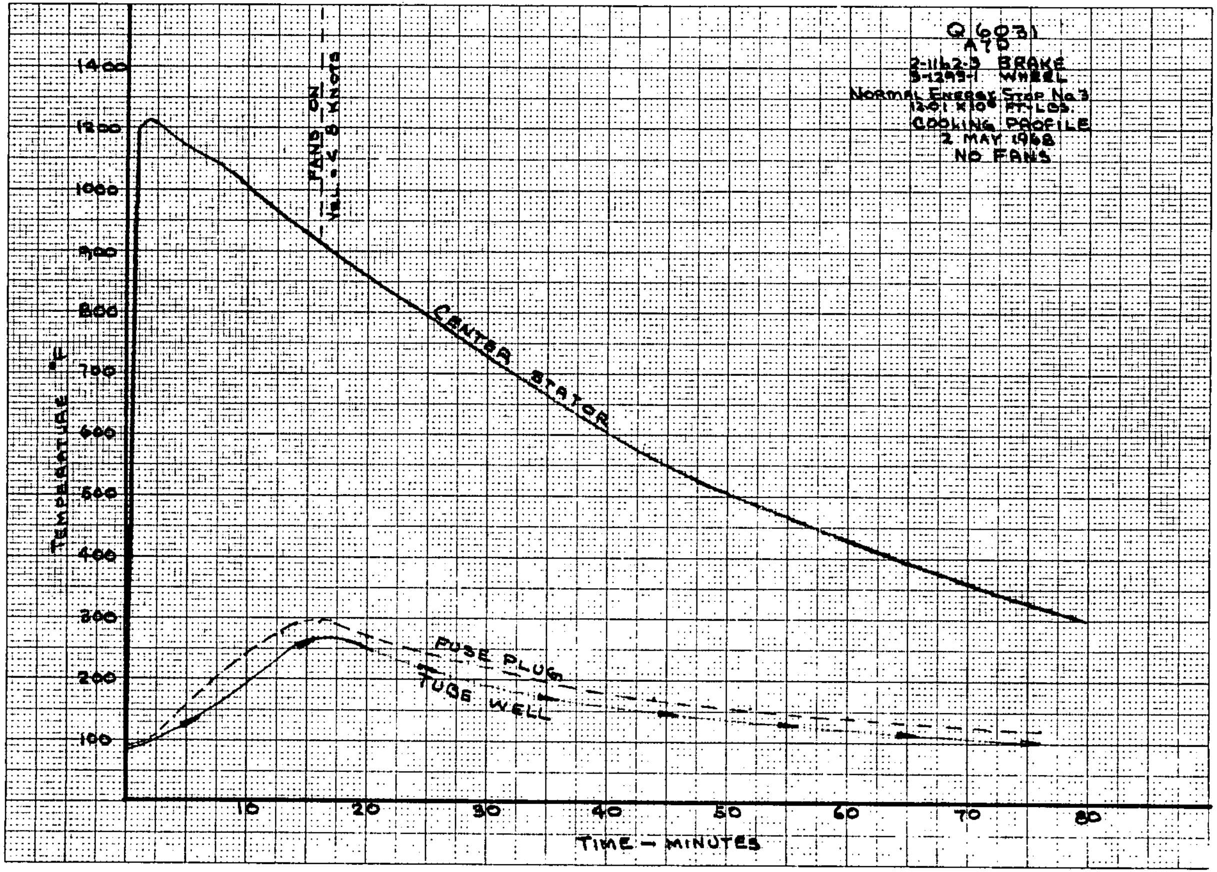

Q 6031
A7D
2-1162-3 BRAKE
3-1293-1 WHEEL
NORMAL ENERGY STOP No. 3
TORQUE-PRESSURE vs TIME
2 MAY 1968
PRESSURE - PSI
PRESSURE
TORQUE
1100
1000
900
800
700
600
500
400
300
200
100
2
4
6
8
10
12
14
16
18
20
22
24
26
TIME - SECONDS

A - 19

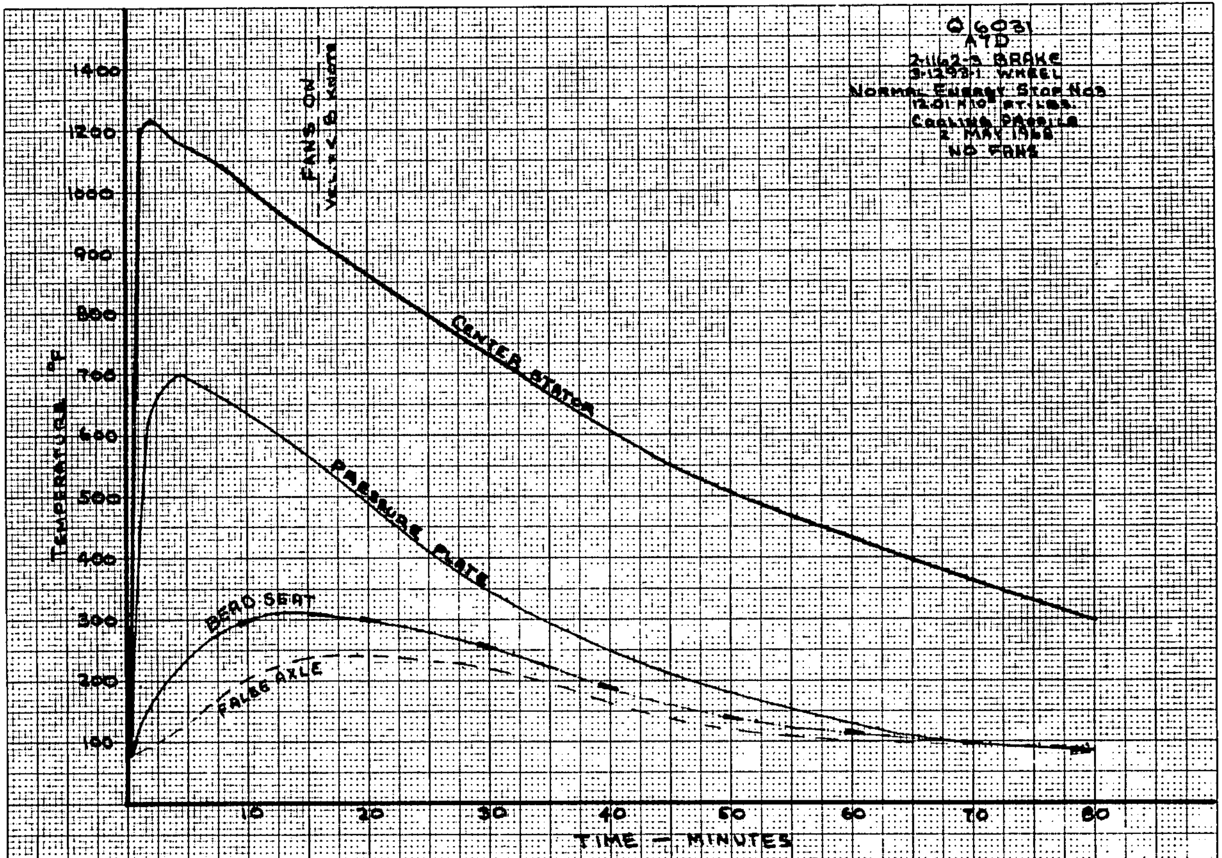
A 20



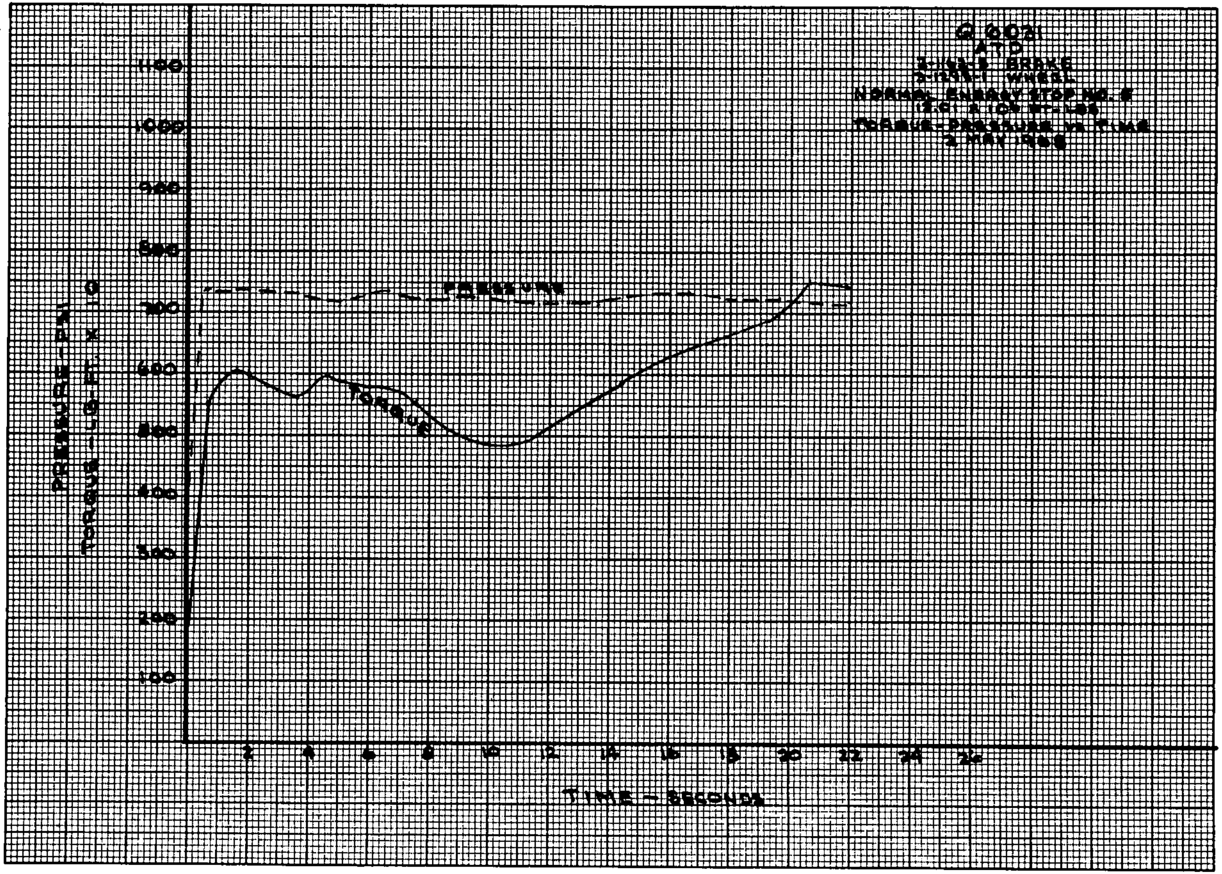
Q 6031
ATD
2-1162-3 BRAKE
3-1293-1 WHEEL
NORMAL ENERGY STOP No. 3
12.01 x 10⁶ FT-LBS.
COOLING PROFILE
2 MAY 1968
NO FANS
FANS ON
VEL. = 4.8 KNOTS
#2 ROTOR
TORQUE PLATE
FLUID
PISTON HOUSING
TEMPERATURE °F
1400
1200
1000
900
800
700
600
500
400
300
200
100
10
20
30
40
50
60
70
80
TIME — MINUTES



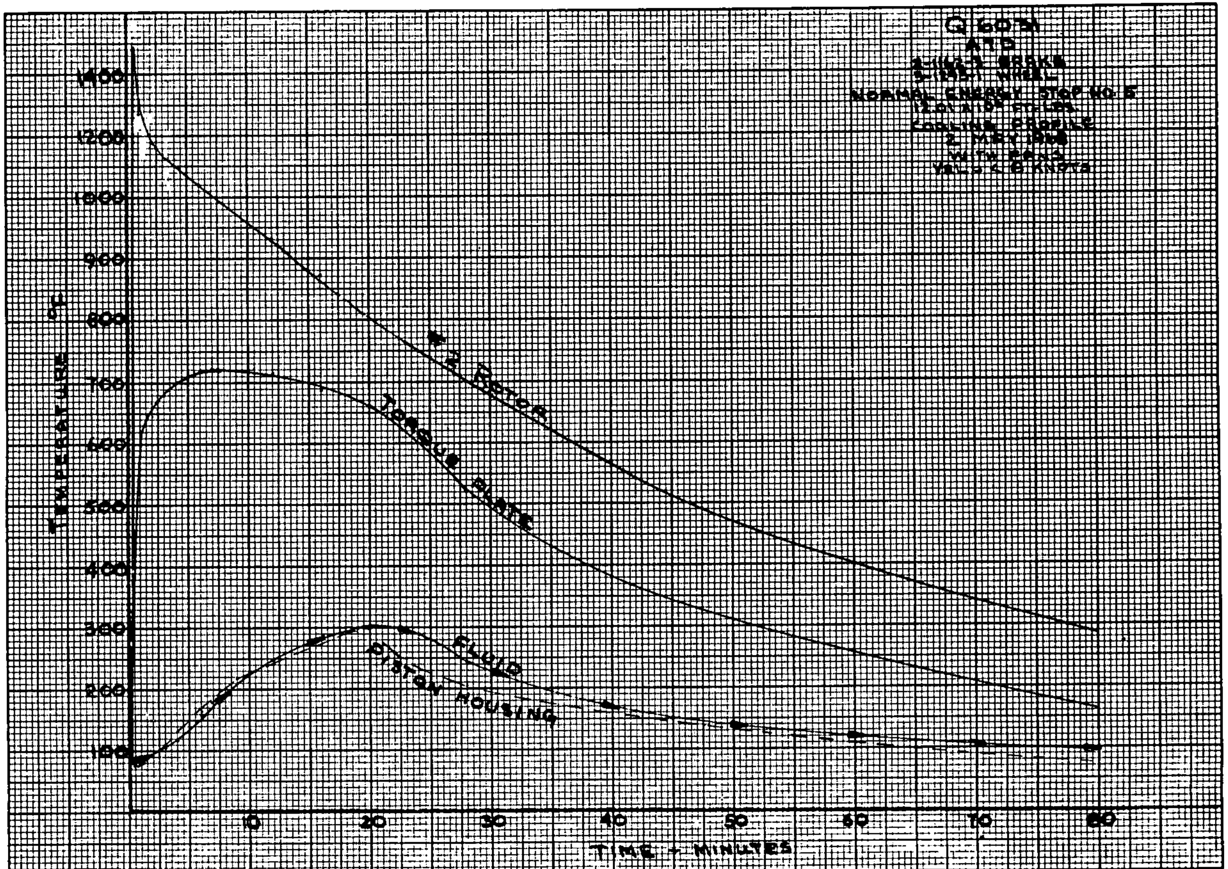
Q(6031)
A70
2-1162-3 BRAKE
3-1299-1 WHEEL
NORMAL ENERGY STOP No. 3
12.01 x 10⁶ FT-LBS.
COOLING PROFILE
2 MAY 1968
NO FANS
FANS ON
TEMPERATURE °F
1400
1200
1000
900
800
700
600
500
400
300
200
100
CENTER STATOR
FUSE PLUG
TUBE WELL
10
20
30
40
50
60
70
80
TIME — MINUTES



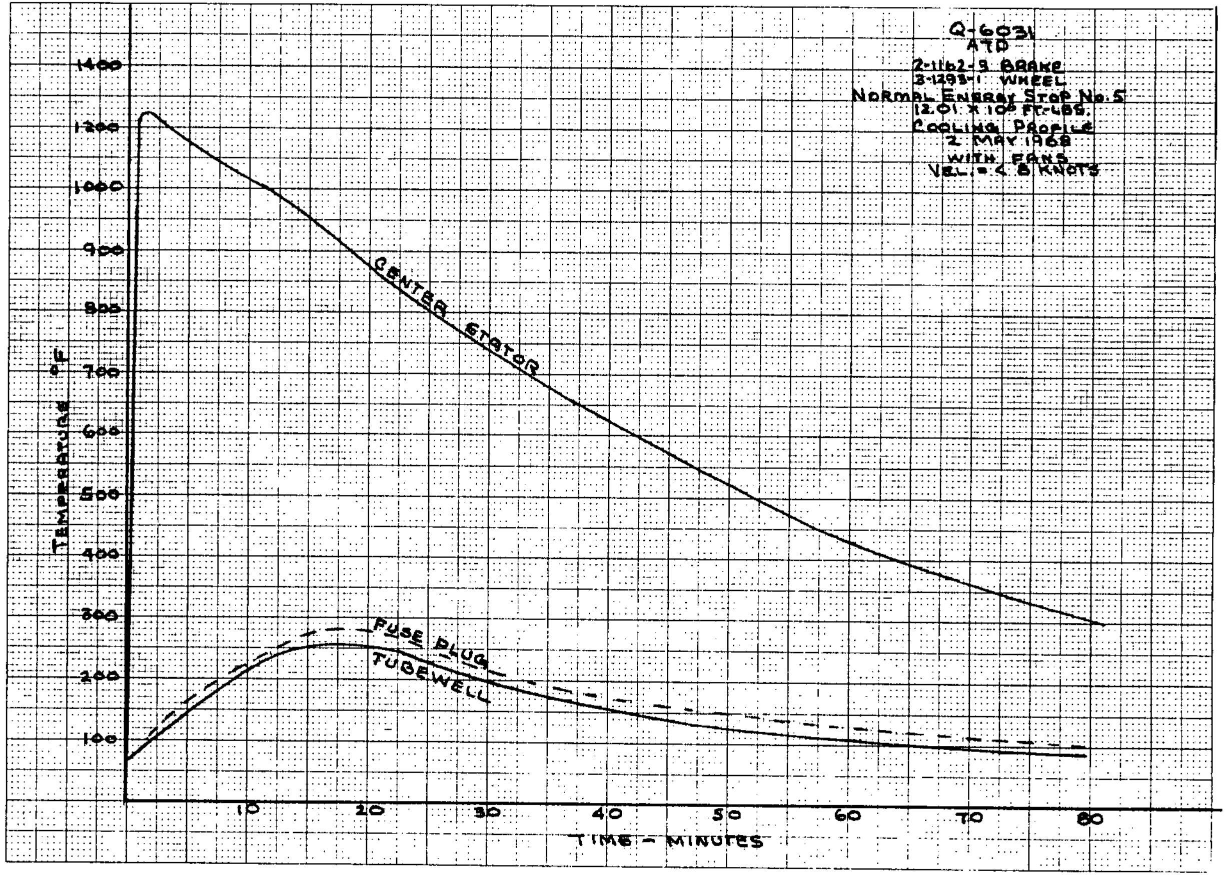
Q 6031
ATD
3-1293-1 WHEEL
NO FANS
FANS ON
TEMPERATURE °F
1400
1200
1000
900
800
700
600
500
400
300
200
100
CENTER STATOR
PRESSURE PLATE
BEAD SEAT
FALSE AXLE
10
20
30
40
50
60
70
80
TIME — MINUTES


ATD
BRAKE
WHEEL
PRESSURE - PSI
TORQUE
PRESSURE
1100
1000
900
800
700
600
500
400
300
200
100
2
4
6
8
10
12
14
16
18
20
22
24
26
TIME - SECONDS

34-919 O - 70 - 6

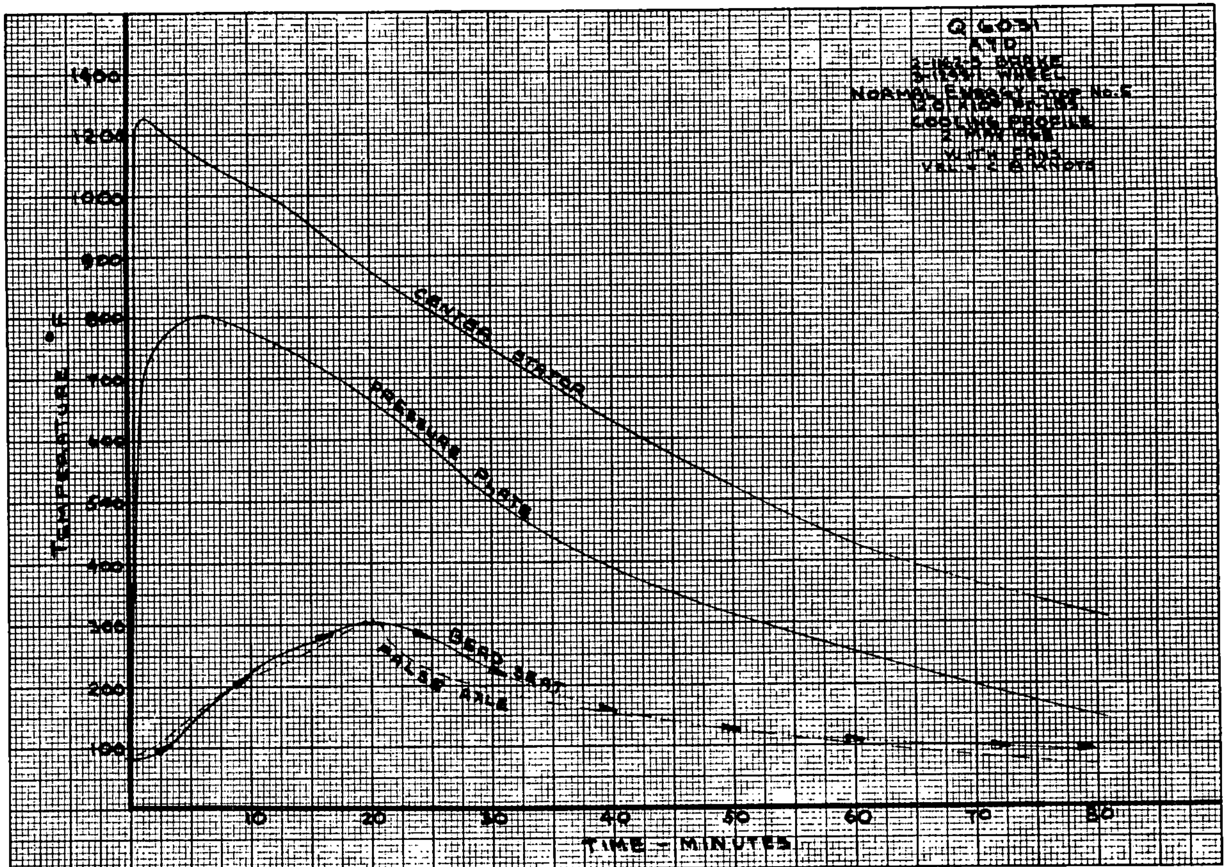


A-24

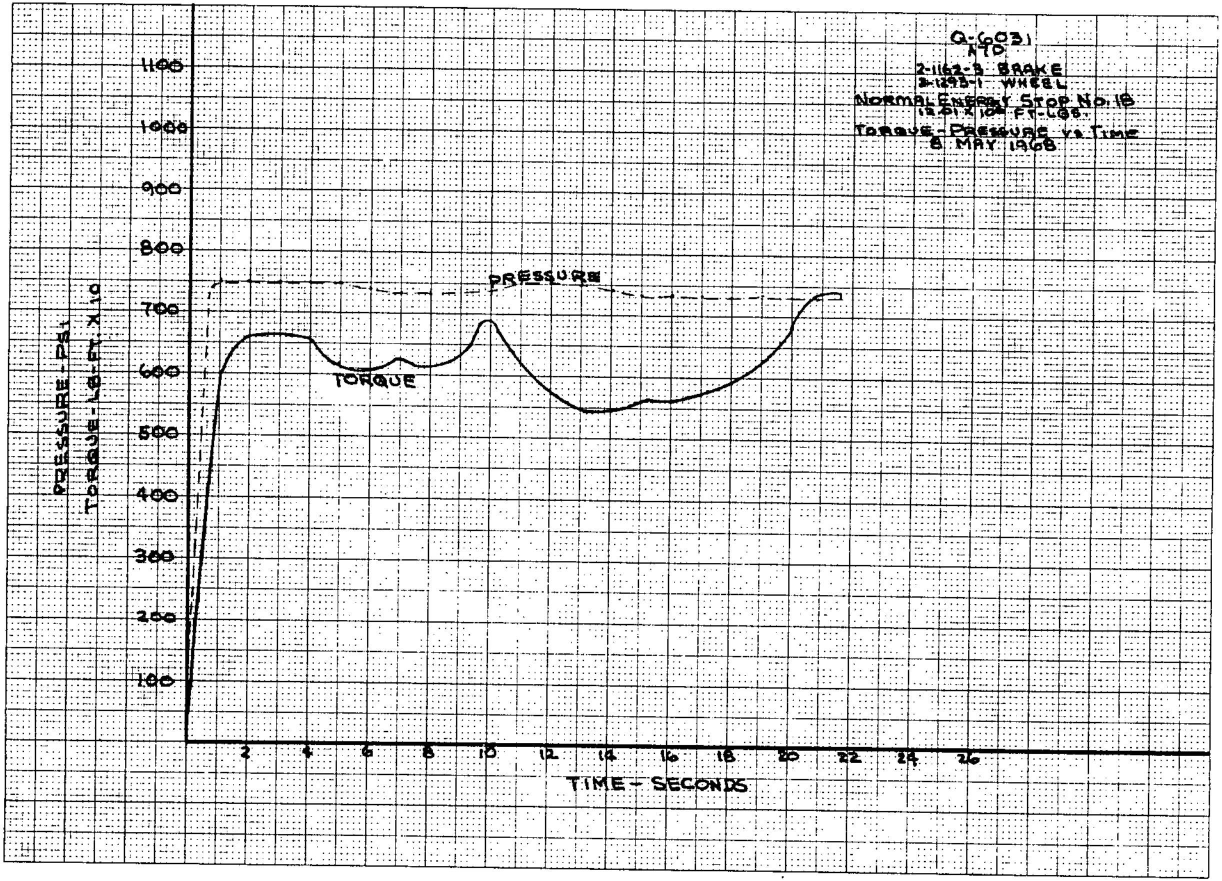

Q-6031
ATD
2-1162-3 BRAKE
3-1293-1 WHEEL
NORMAL ENERGY STOP No. 5
12.01 X 10⁶ FT-LBS.
COOLING PROFILE
2 MAY 1968
WITH FANS
VEL. = < 8 KNOTS
TEMPERATURE °F
1400
1200
1000
900
800
700
600
500
400
300
200
100
CENTER STATOR
FUSE PLUG
TUBEWELL
10
20
30
40
50
60
70
80
TIME – MINUTES

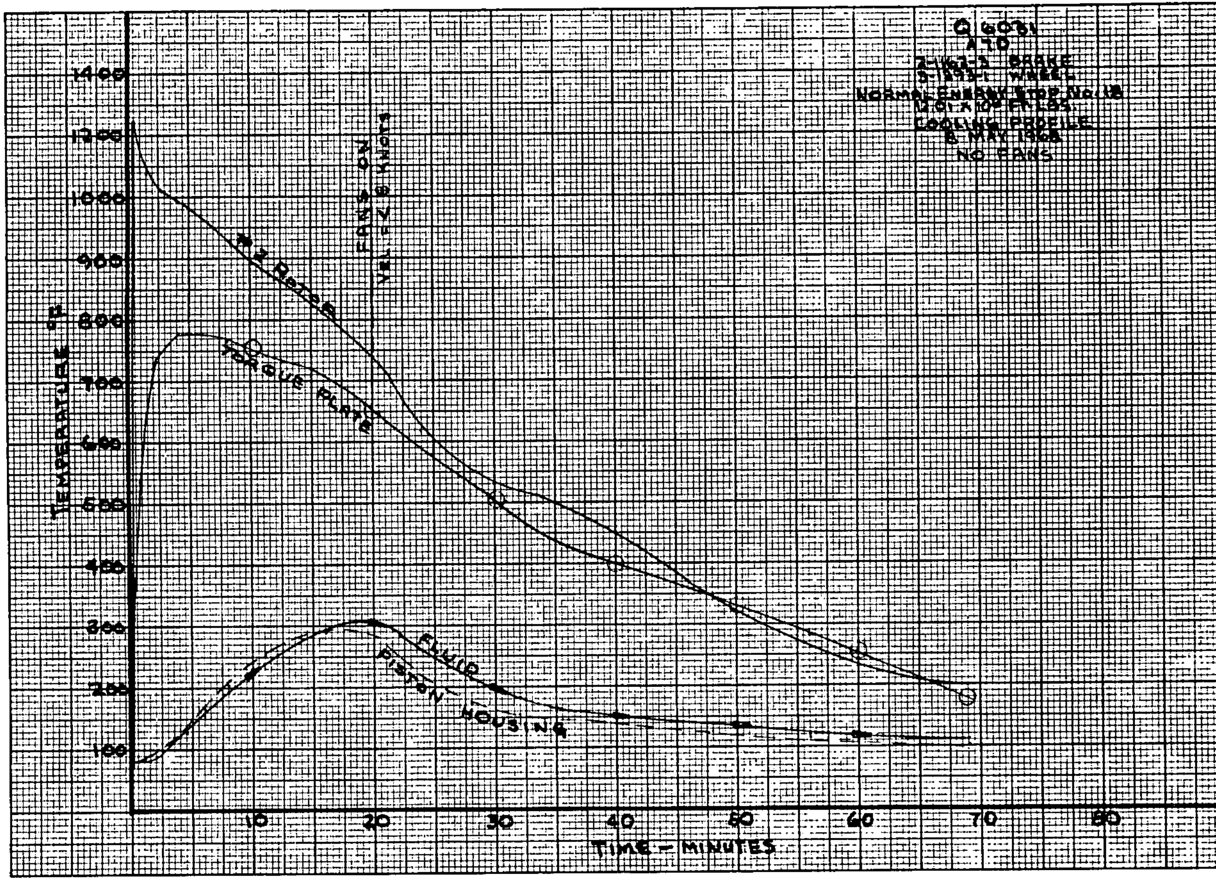
A-25

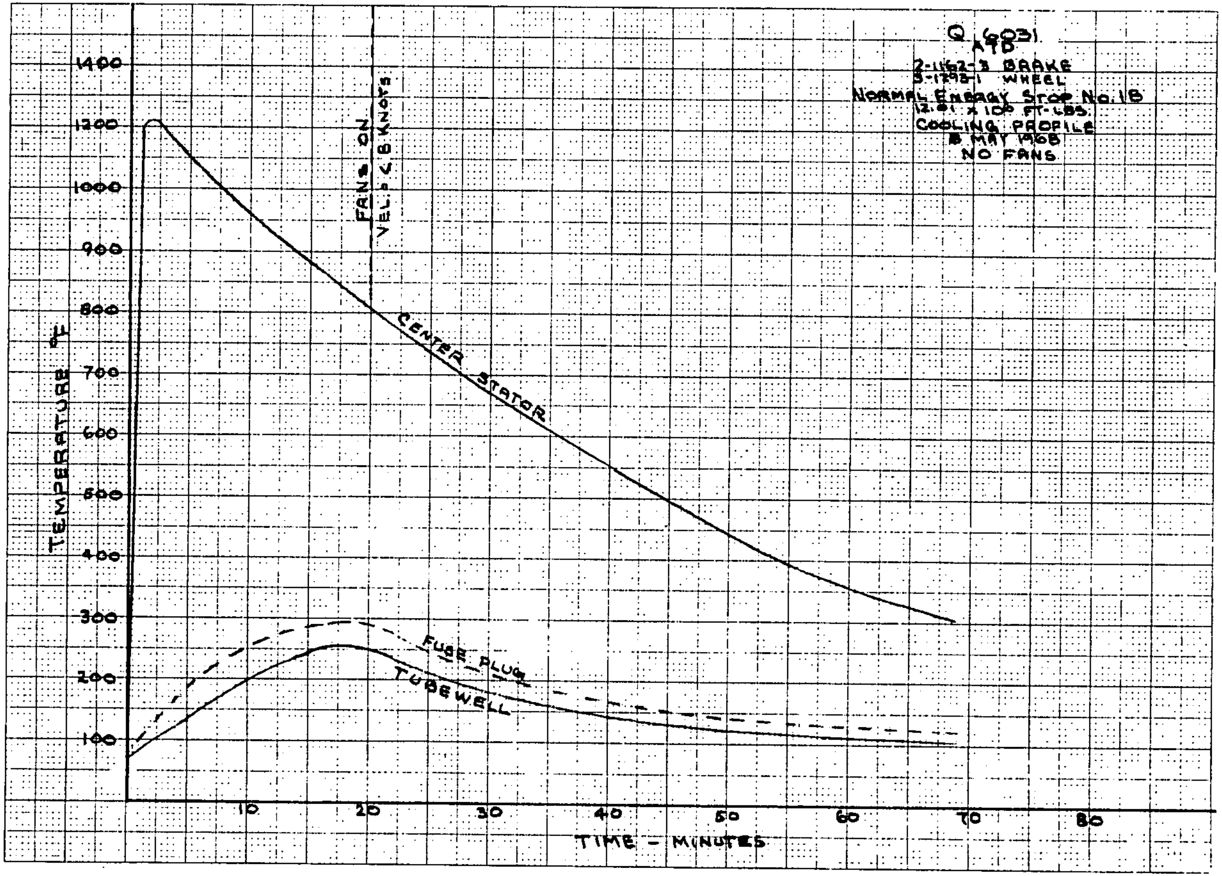
V-26



Q 6031
AND
NORMAL ENERGY STOP No. 5
COOLING PROFILE
WITH FANS
TEMPERATURE °F
1400
1200
1000
900
800
700
600
500
400
300
200
100
10
20
30
40
50
60
70
80
TIME – MINUTES
CENTER STATOR
PRESSURE PLATE
BEAD SEAT
FALSE AXLE

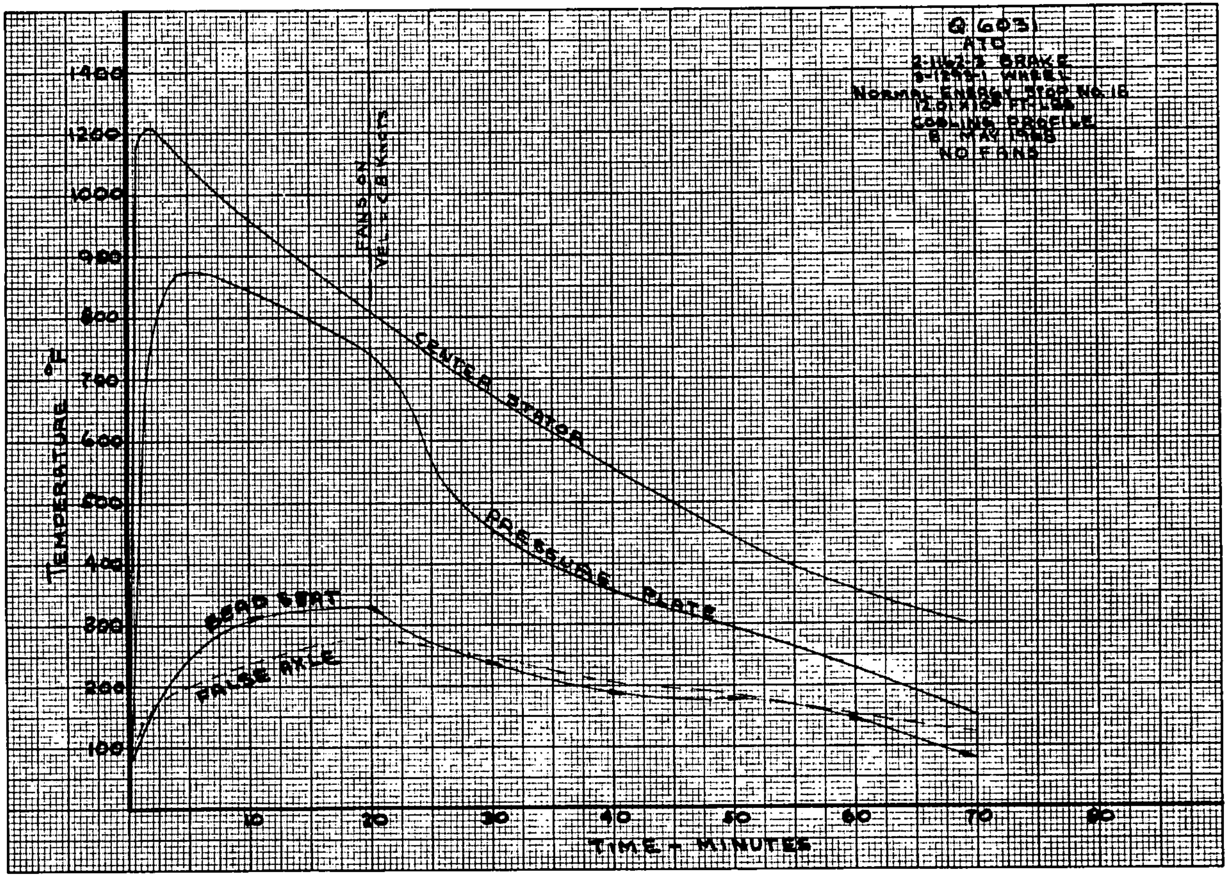

Q-6031
NTD
2-1162-3 BRAKE
3-1293-1 WHEEL
NORMAL ENERGY STOP NO. 18
12.91 X 10⁶ FT-LBS.
TORQUE-PRESSURE VS TIME
8 MAY 1968
PRESSURE - PSI
TORQUE - LB-FT. X 10
1100
1000
900
800
700
600
500
400
300
200
100
PRESSURE
TORQUE
2
4
6
8
10
12
14
16
18
20
22
24
26
TIME - SECONDS


Q 6031
ATD
2-1167-3 BRAKE
3-1275-1 WHEEL
NORMAL ENERGY STOP No. 18
12.01 X 10⁶ FT-LBS.
COOLING PROFILE
8 MAY 1968
NO FANS
FANS ON
VEL = 26 KNOTS
#2 ROTOR
TORQUE PLATE
FLUID
PISTON HOUSING
TEMPERATURE °F
1400
1200
1000
900
800
700
600
500
400
300
200
100
10
20
30
40
50
60
70
80
TIME — MINUTES

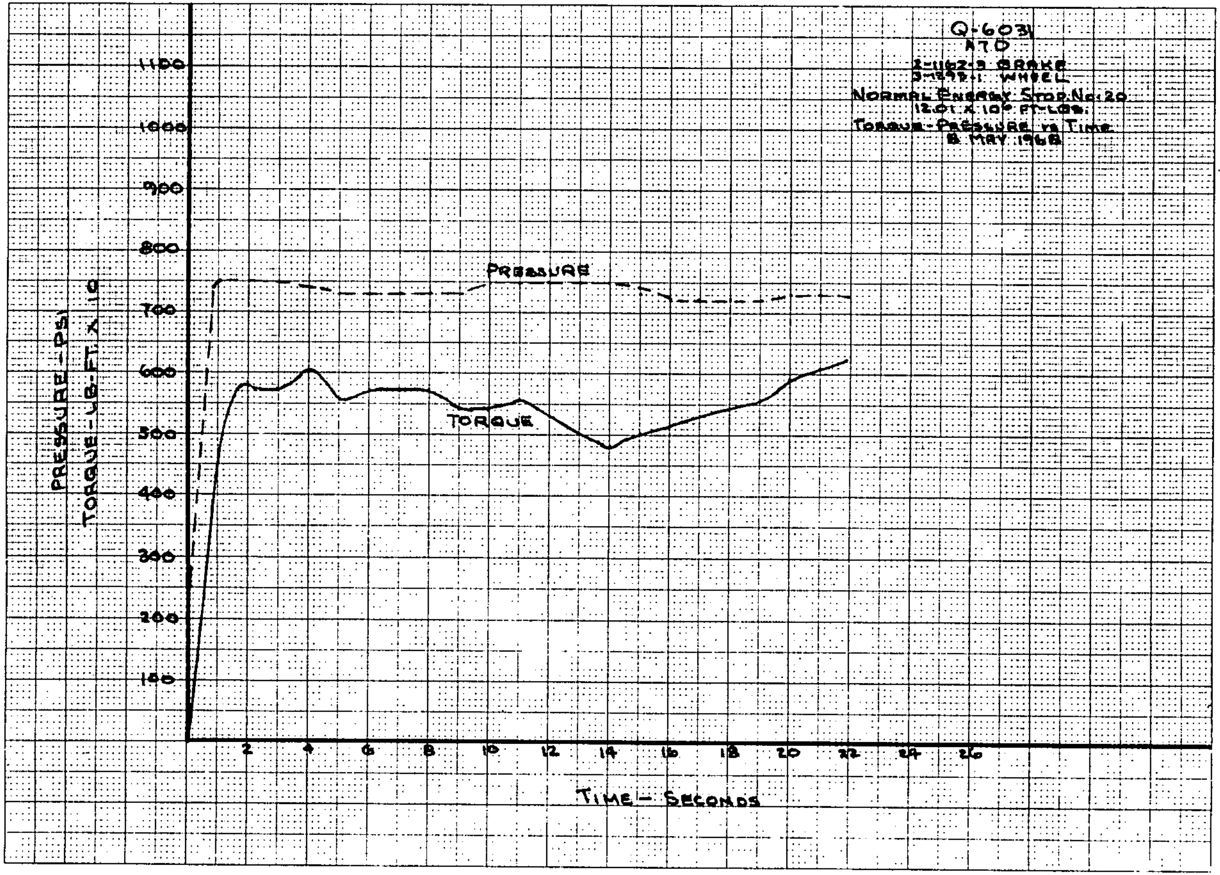

Q 6031
ATD
2-1162-3 BRAKE
3-1293-1 WHEEL
NORMAL ENERGY STOP No. 18
FT-LBS.
COOLING PROFILE
MAY 1968
NO FANS
FANS ON
VEL. = 6.8 KNOTS
CENTER STATOR
FUSE PLUG
TUBEWELL
TEMPERATURE °F
1400
1200
1000
900
800
700
600
500
400
300
200
100
10
20
30
40
50
60
70
80
TIME – MINUTES

A-29

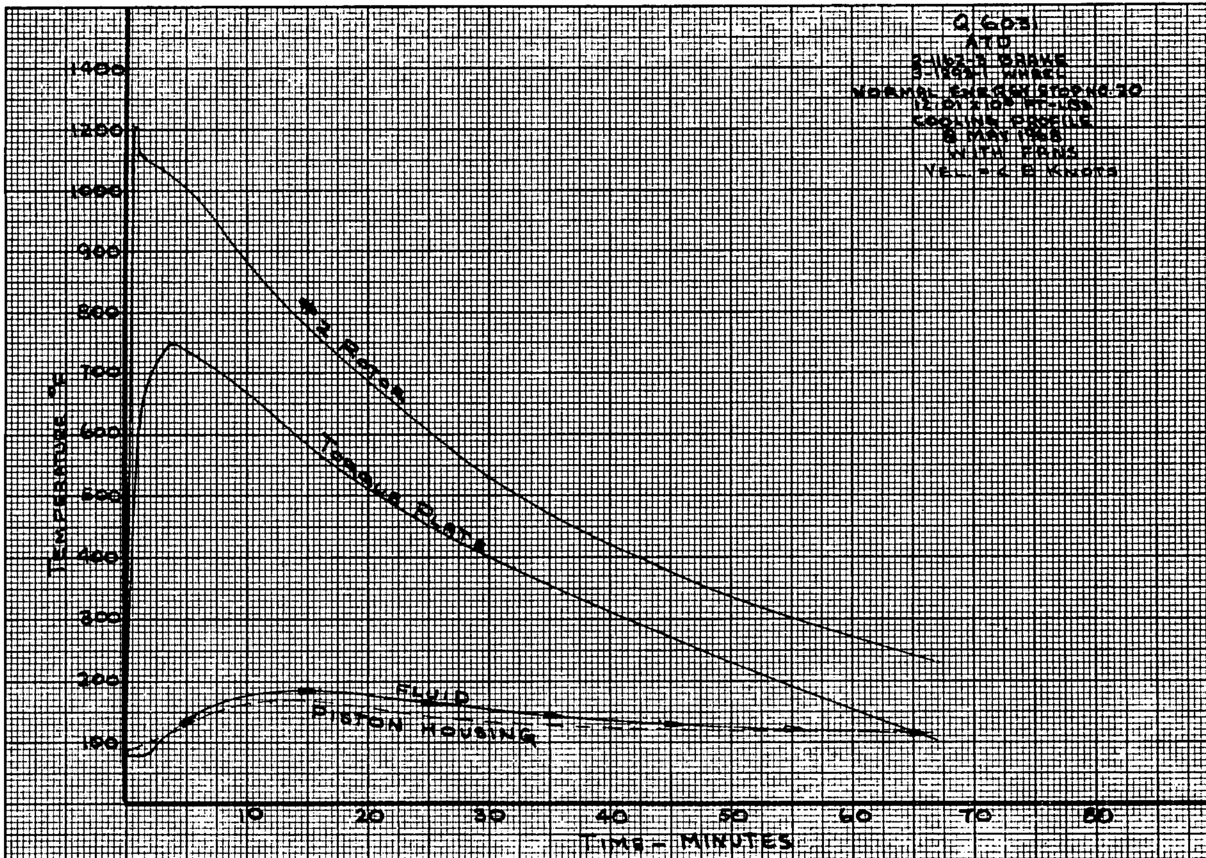
A-30



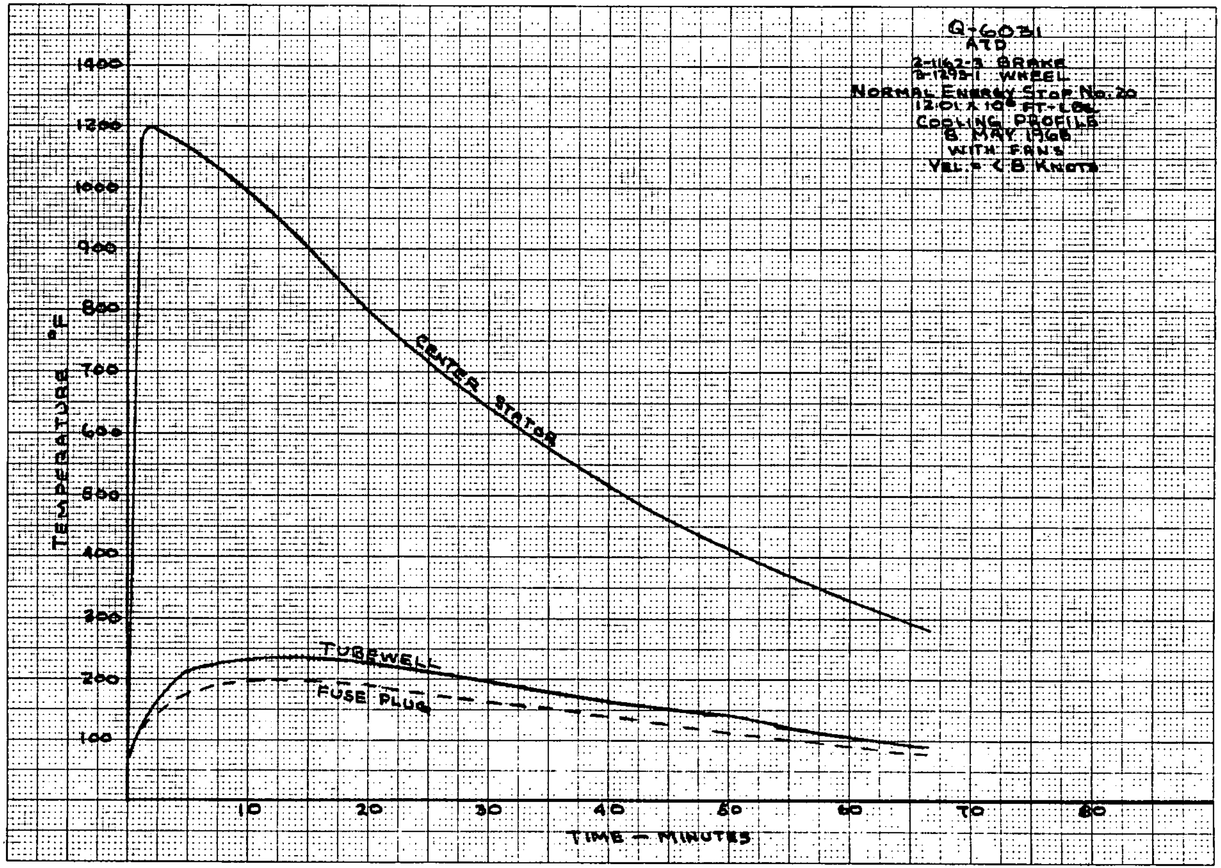
Q 6031
ATD
BRAKE
WHEEL
NORMAL ENERGY STOP No. 16
COOLING PROFILE
NO FANS
FANS ON
TEMPERATURE °F
TIME - MINUTES
CENTER STATOR
PRESSURE PLATE
BEAD SEAT
FALSE AXLE
1400
1200
1000
900
800
700
600
500
400
300
200
100
10
20
30
40
50
60
70
80

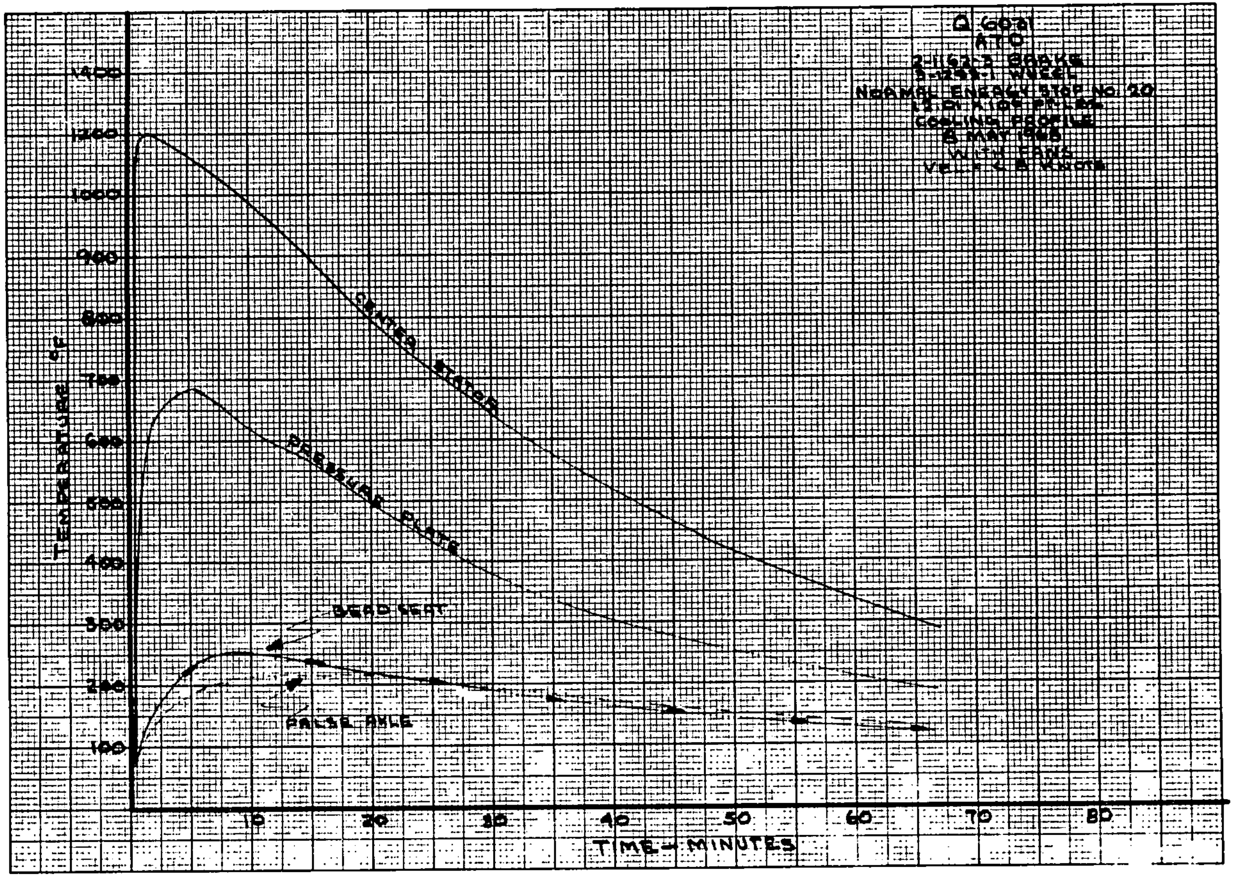

Q-6031
ATD
BRAKE
WHEEL
NORMAL ENERGY STOP No. 20
12.01 X 10^6 FT-LBS.
TORQUE-PRESSURE vs TIME
8 MAY 1968
PRESSURE
TORQUE
PRESSURE - PSI
TORQUE - LB-FT X 10
1100
1000
900
800
700
600
500
400
300
200
100
2
4
6
8
10
12
14
16
18
20
22
24
26
TIME - SECONDS

A-32

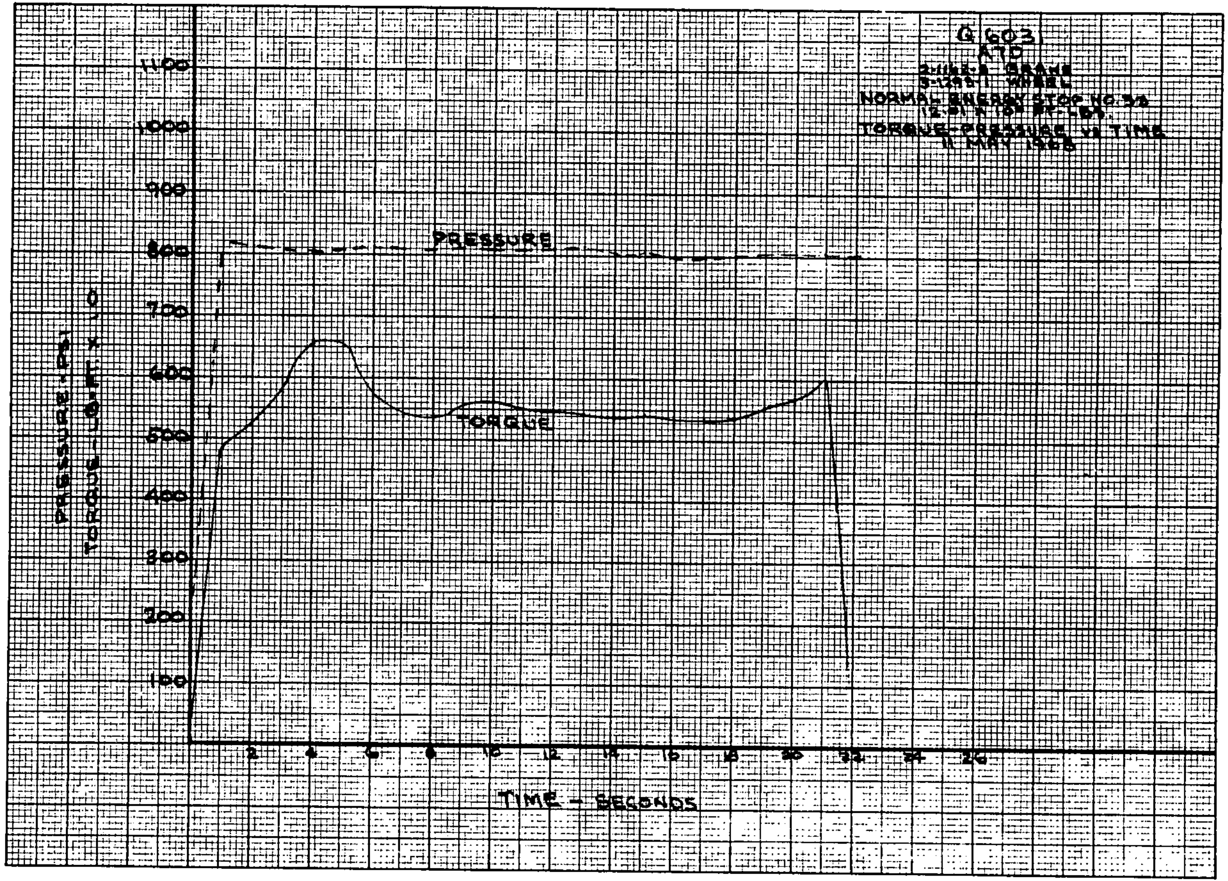

Q 6031
ATD
COOLING PROFILE
WITH FANS
1400
1200
1000
900
800
700
600
500
400
300
200
100
10
20
30
40
50
60
70
80
TIME – MINUTES
TORQUE PLATE
FLUID
PISTON HOUSING

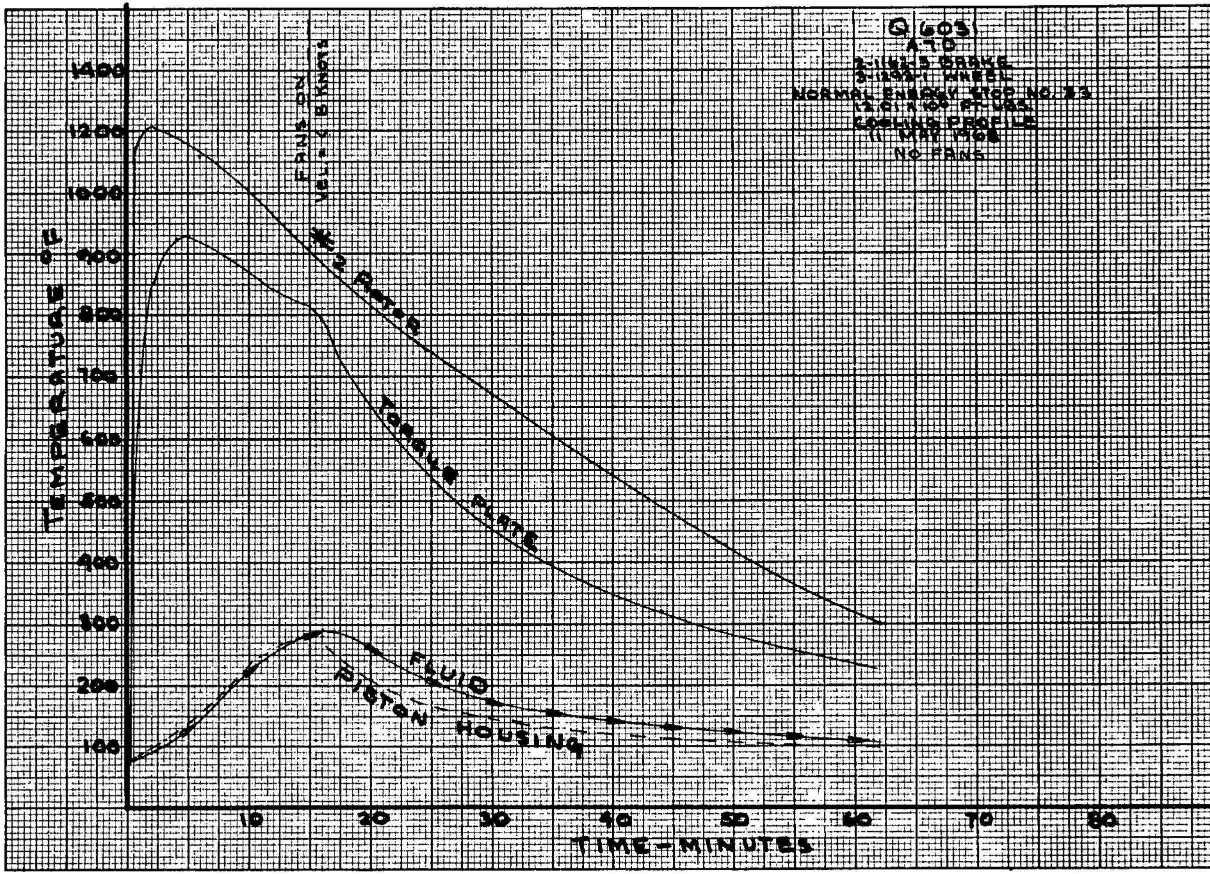
A-33


Q-6031
ATD
BRAKE
WHEEL
NORMAL ENERGY STOP No. 20
COOLING PROFILE
WITH FANS
TEMPERATURE °F
1400
1200
1000
900
800
700
600
500
400
300
200
100
CENTER STATOR
TUBEWELL
FUSE PLUG
10
20
30
40
50
60
70
80
TIME — MINUTES


ATO
2-1162-3 BRAKE
NORMAL ENERGY STOP NO. 20
COOLING PROFILE
WITH FANS
TEMPERATURE °F
1400
1200
1000
900
800
700
600
500
400
300
200
100
CENTER STATOR
PRESSURE PLATE
BEAD SEAT
FALSE AXLE
10
20
30
40
50
60
70
80
TIME — MINUTES

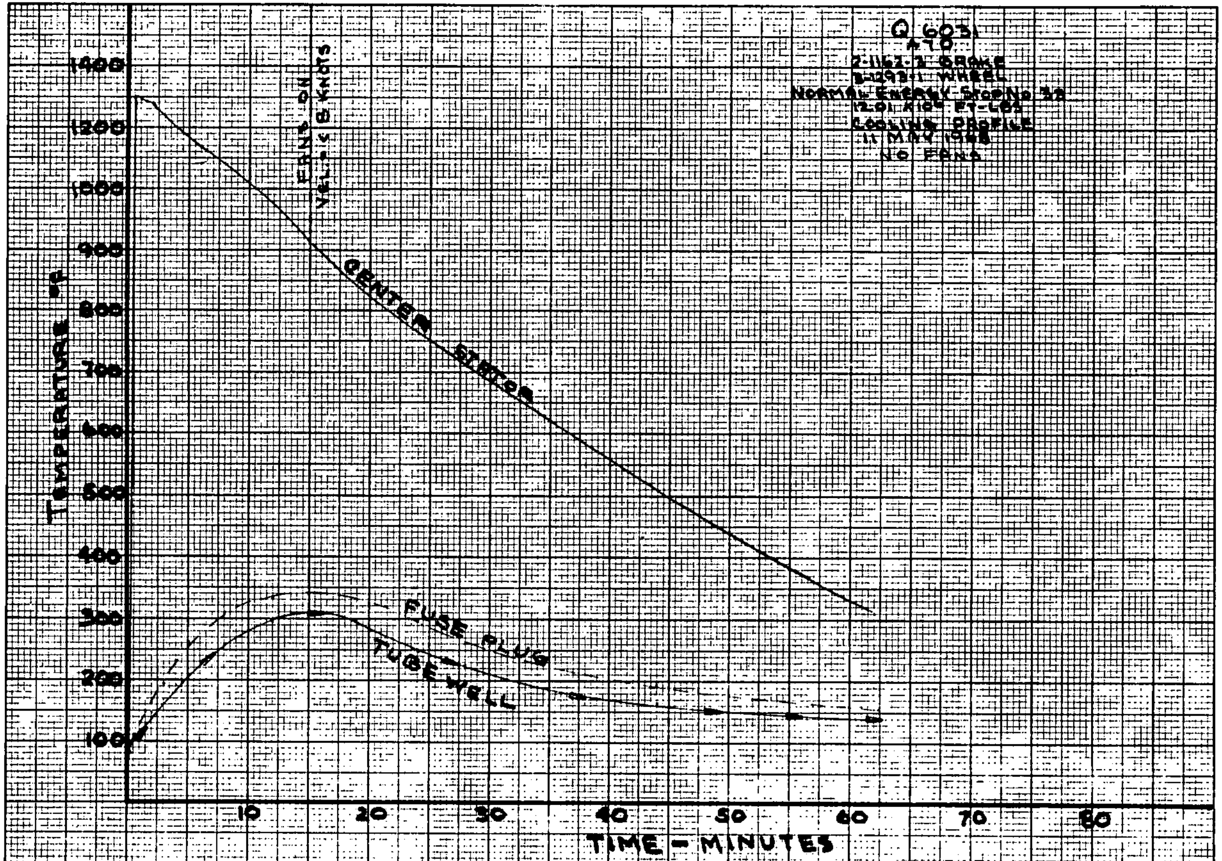
A-34

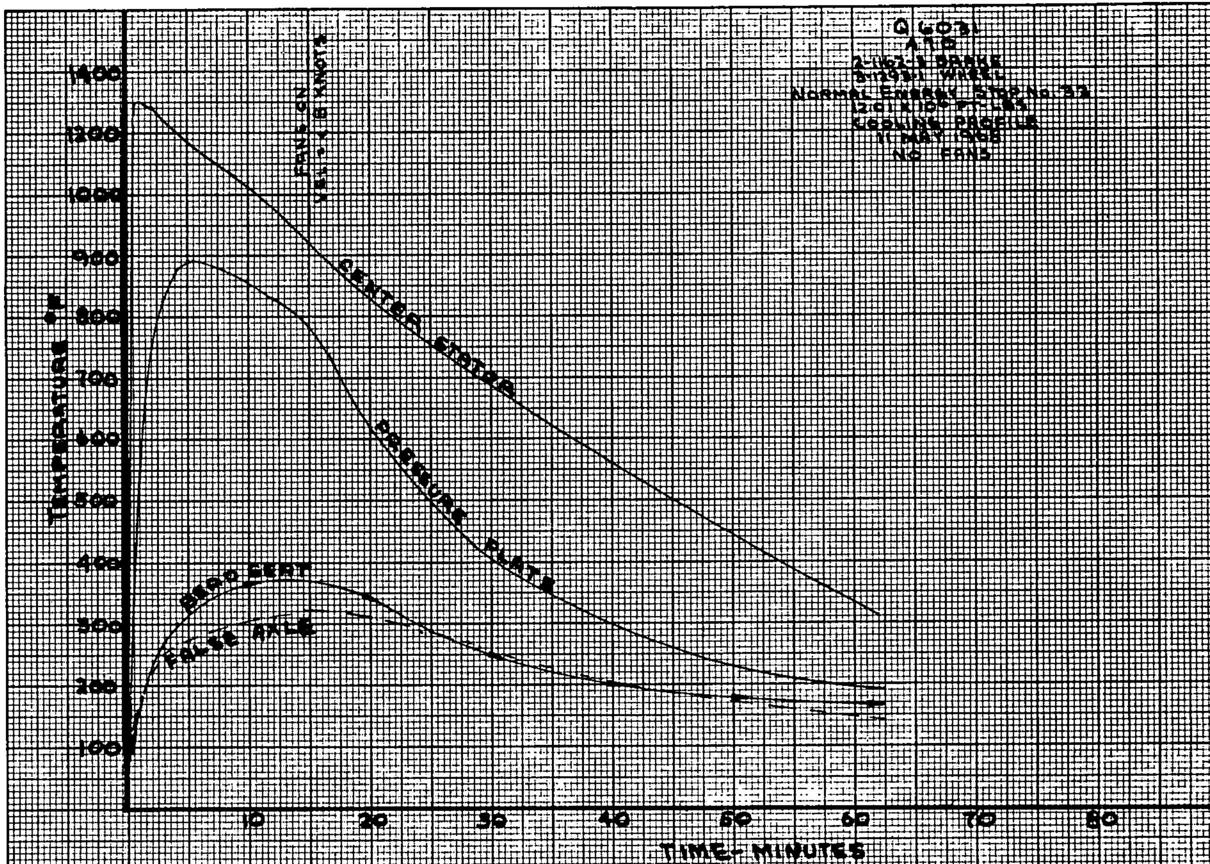

G 603
ATD
NORMAL ENERGY STOP
TORQUE-PRESSURE VS TIME
PRESSURE
TORQUE
PRESSURE-PSI
TORQUE-LB-FT x 10
1100
1000
900
800
700
600
500
400
300
200
100
2
4
6
8
10
12
14
16
18
20
22
24
26
TIME - SECONDS

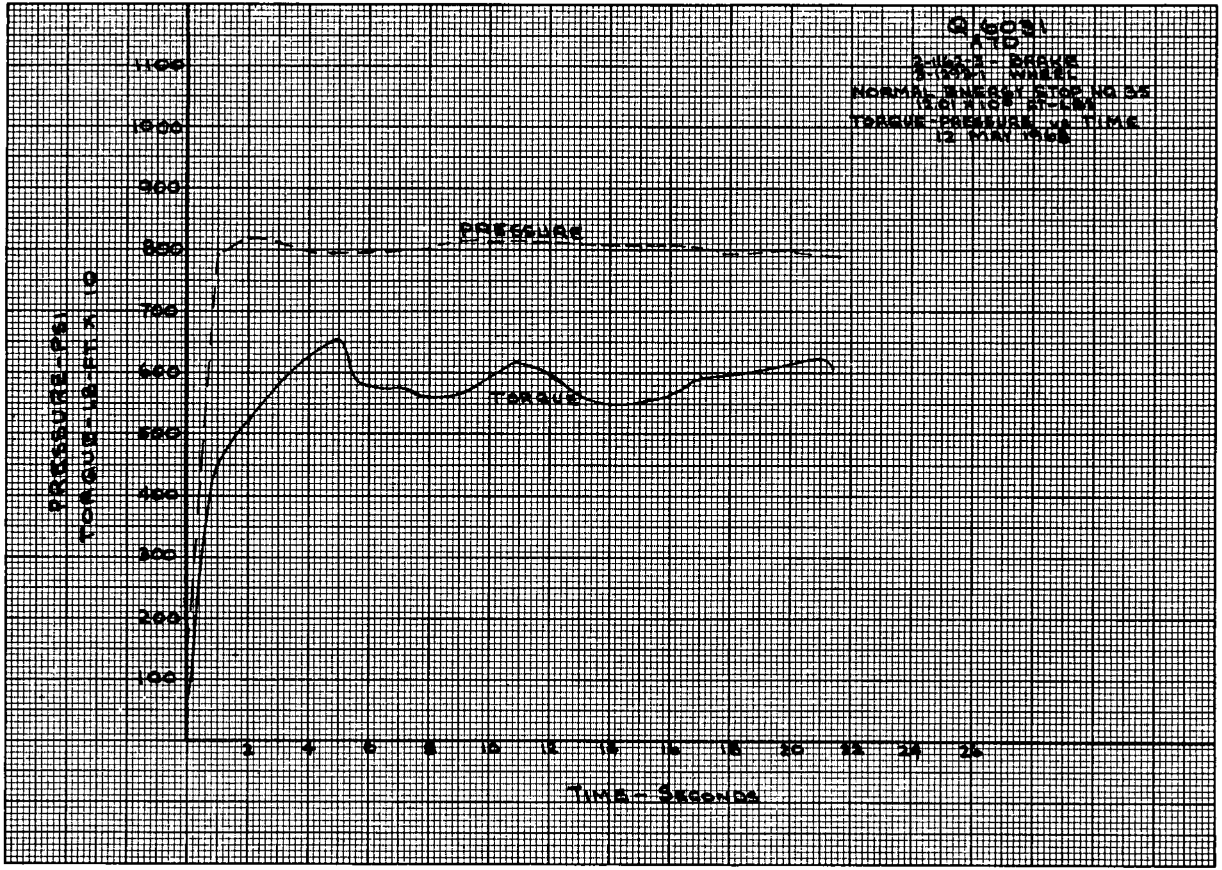


Q 603
ATD
NORMAL ENERGY STOP NO. 23
COOLING PROFILE
11 MAY 1968
NO FANS
FANS ON
VEL. = 4.8 KNOTS
#2 ROTOR
TORQUE PLATE
FLUID
PISTON HOUSING
TEMPERATURE °F
1400
1200
1000
900
800
700
600
500
400
300
200
100
10
20
30
40
50
60
70
80
TIME - MINUTES

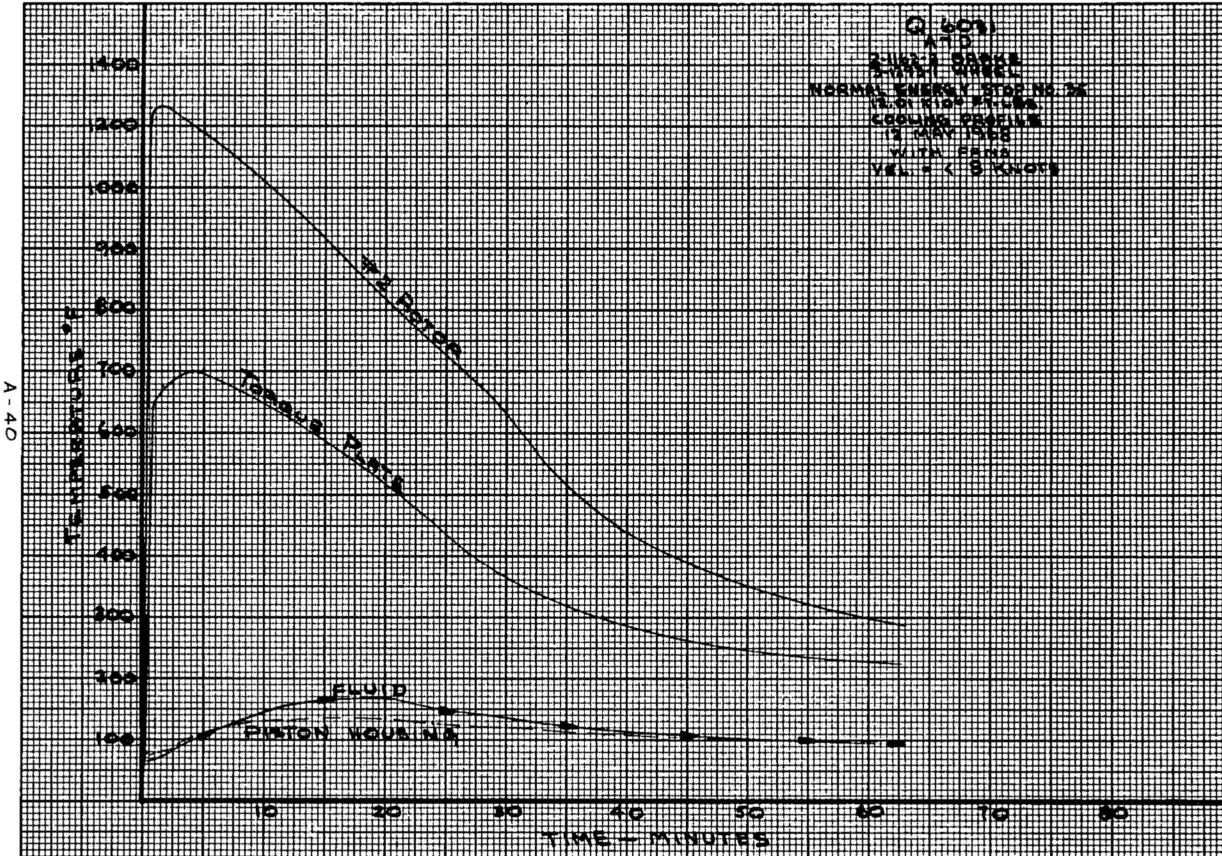
A-36


Q 6031
ATO
2-1162-2 BRAKE
3-1293-1 WHEEL
NORMAL ENERGY STOP No 32
12.01 x 10^6 FT-LBS
COOLING PROFILE
11 MAY 1968
NO FANS
FANS ON
VEL. < 8 KNOTS
CENTER STATOR
FUSE PLUG
TUBE WELL
TEMPERATURE °F
1400
1200
1000
900
800
700
600
500
400
300
200
100
10
20
30
40
50
60
70
80
TIME - MINUTES


Q 6031
2-1162-3 BRAKE
3-1293-1 WHEEL
NORMAL ENERGY STOP No. 32
COOLING PROFILE
NO FANS
FANS ON
KNOTS
CENTER STATOR
PRESSURE PLATE
PRESS. PLATE
FALSE AXLE
TEMPERATURE °F
1400
1200
1000
900
800
700
600
500
400
300
200
100
10
20
30
40
50
60
70
80
TIME- MINUTES

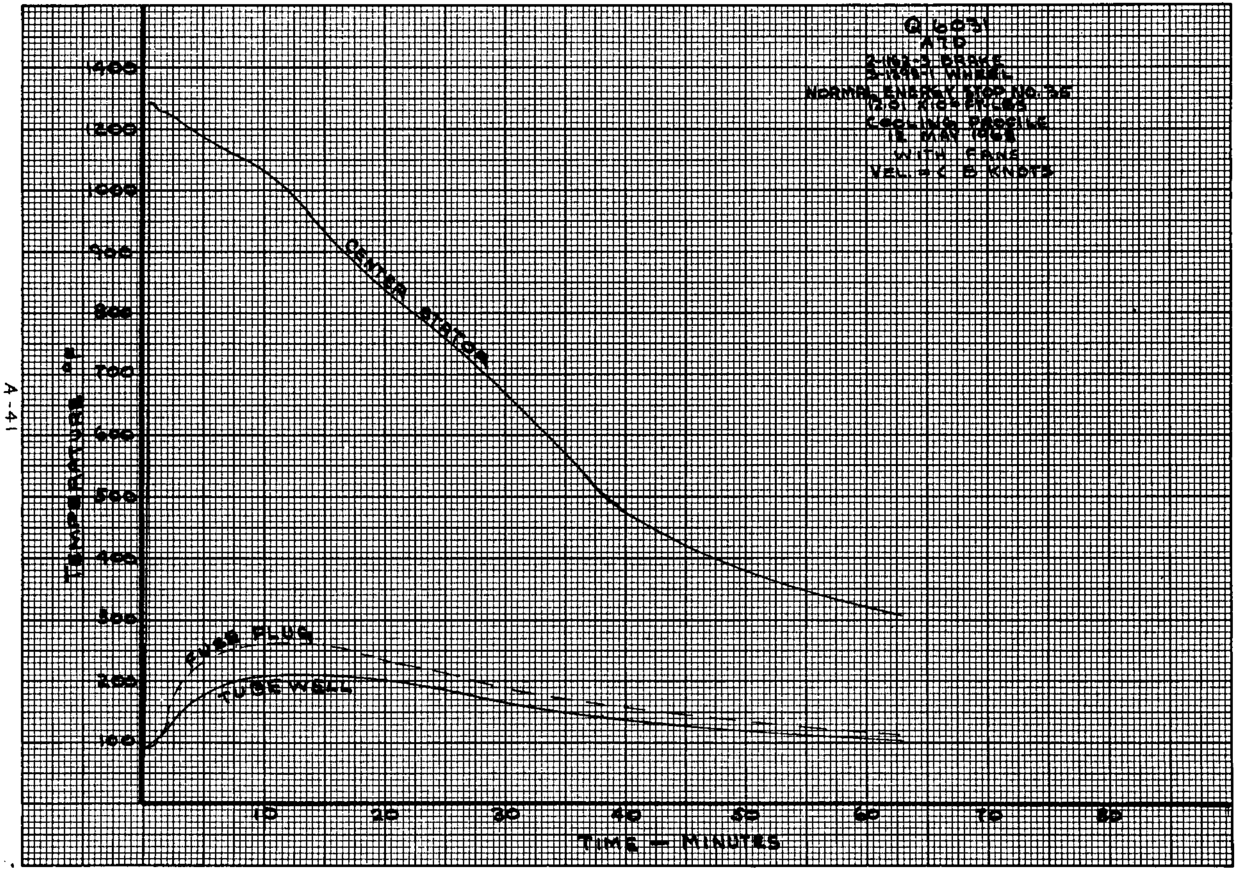

Q 6031
ATD
NORMAL ENERGY STOP NO 35
TORQUE-PRESSURE vs TIME
PRESSURE
TORQUE
PRESSURE - PSI
TORQUE - LB-FT. X 10
1100
1000
900
800
700
600
500
400
300
200
100
2
4
6
8
10
12
14
16
18
20
22
24
26
TIME - SECONDS

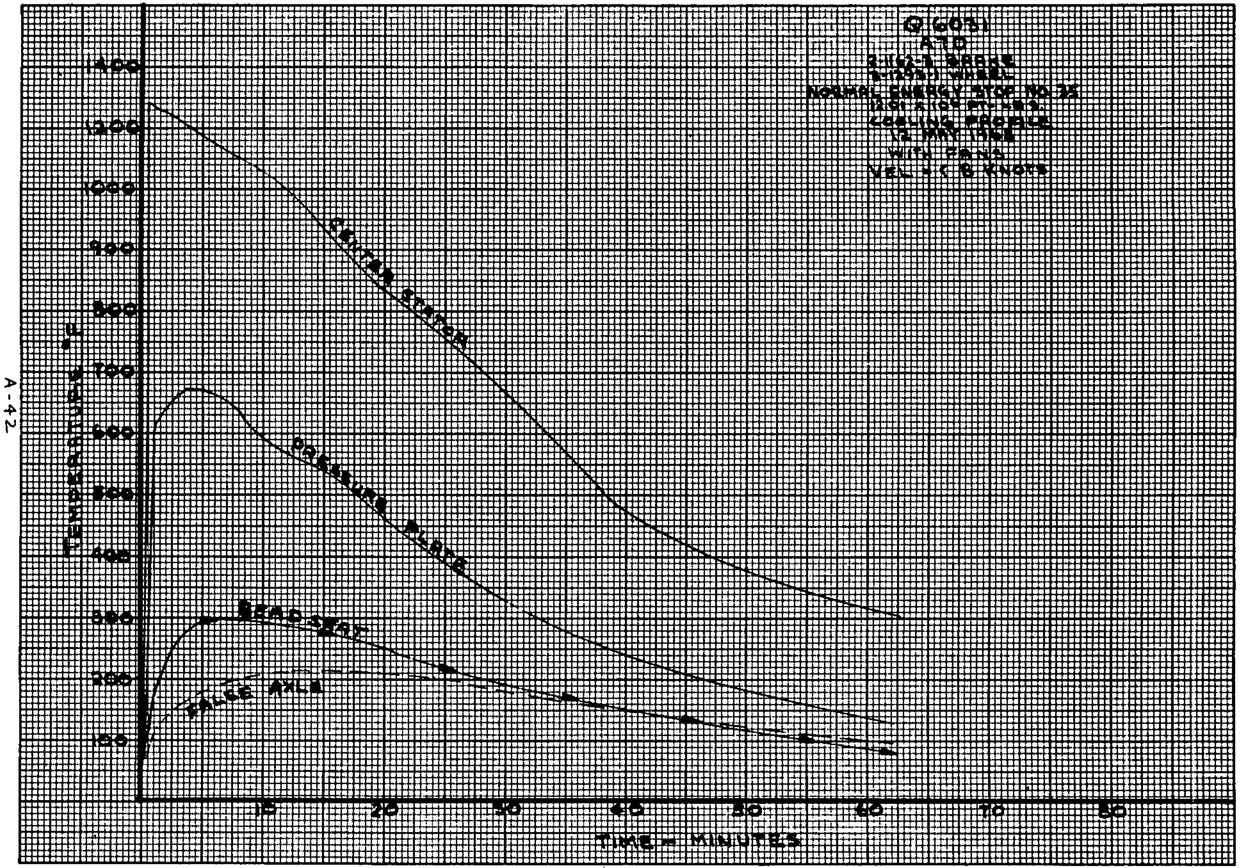
34-919 O - 70 - 7

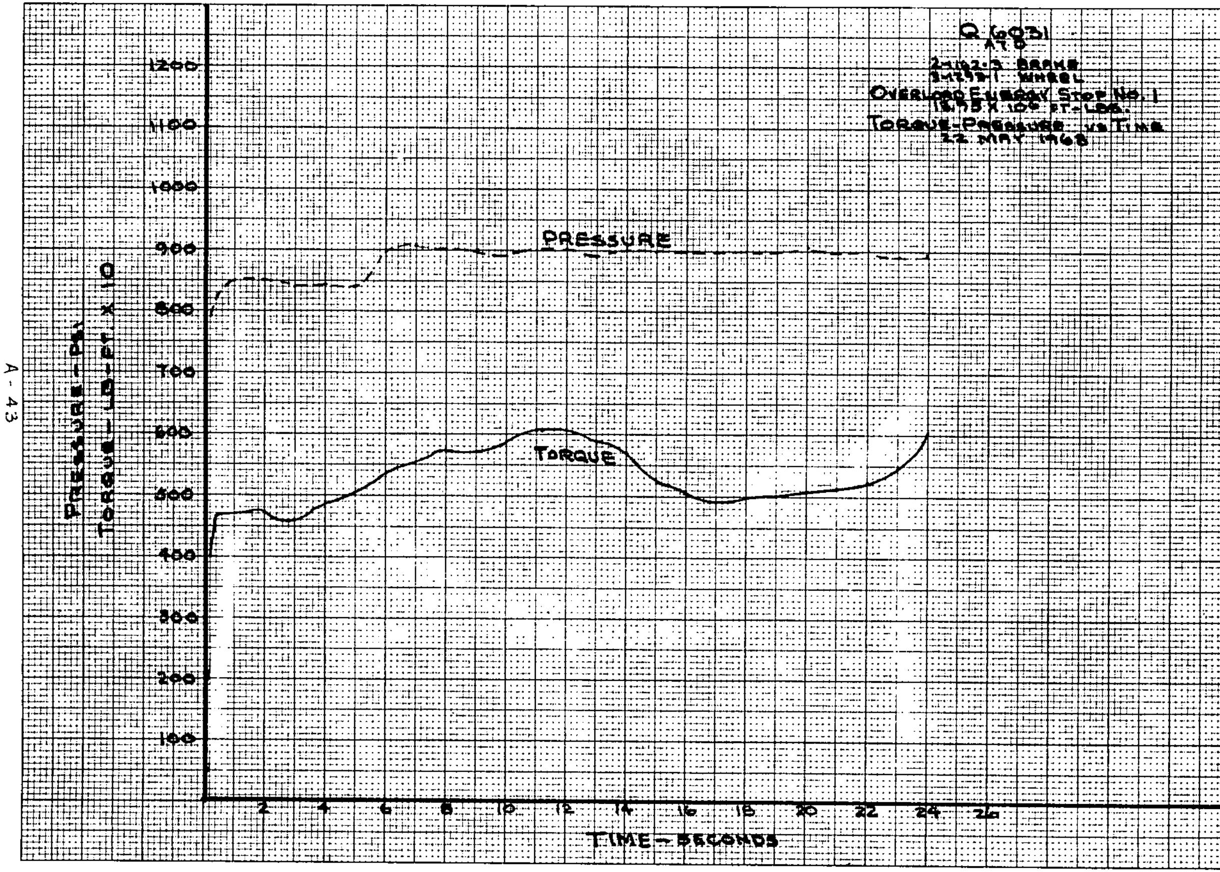


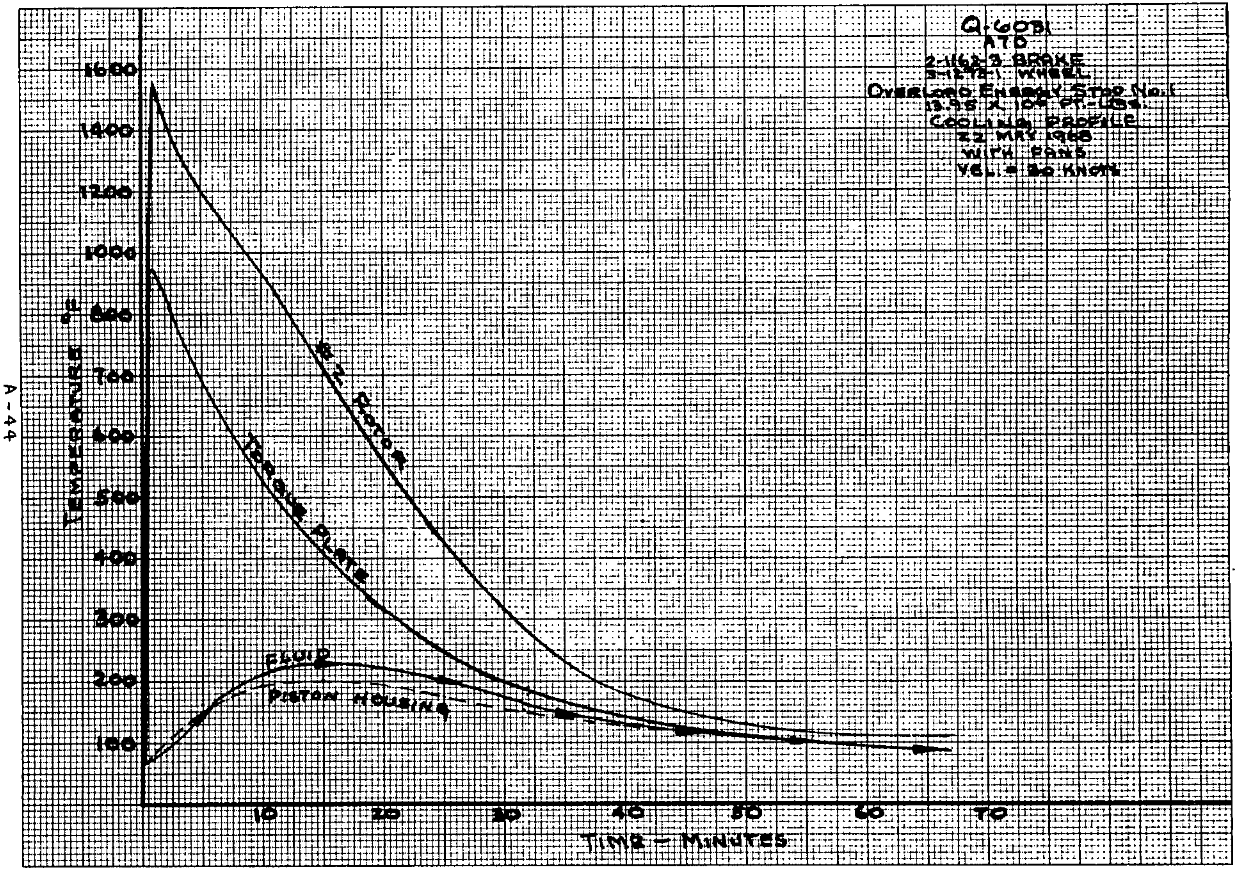
ATD
NORMAL ENERGY STOP NO.
COOLING PROFILE
12 MAY 1968
8 KNOTS
TEMPERATURE °F
TIME — MINUTES
10
20
30
40
50
60
70
80
#2 ROTOR
TORQUE PLATE
FLUID
PISTON HOUSING

A-41


Q 6031
ATD
NORMAL ENERGY STOP NO. 35
COOLING PROFILE
WITH FANS
KNOTS
TEMPERATURE °F
1400
1200
1000
900
800
700
600
500
400
300
200
100
10
20
30
40
50
60
70
80
TIME — MINUTES
CENTER STATOR
FUSE PLUG
TUBE WELL

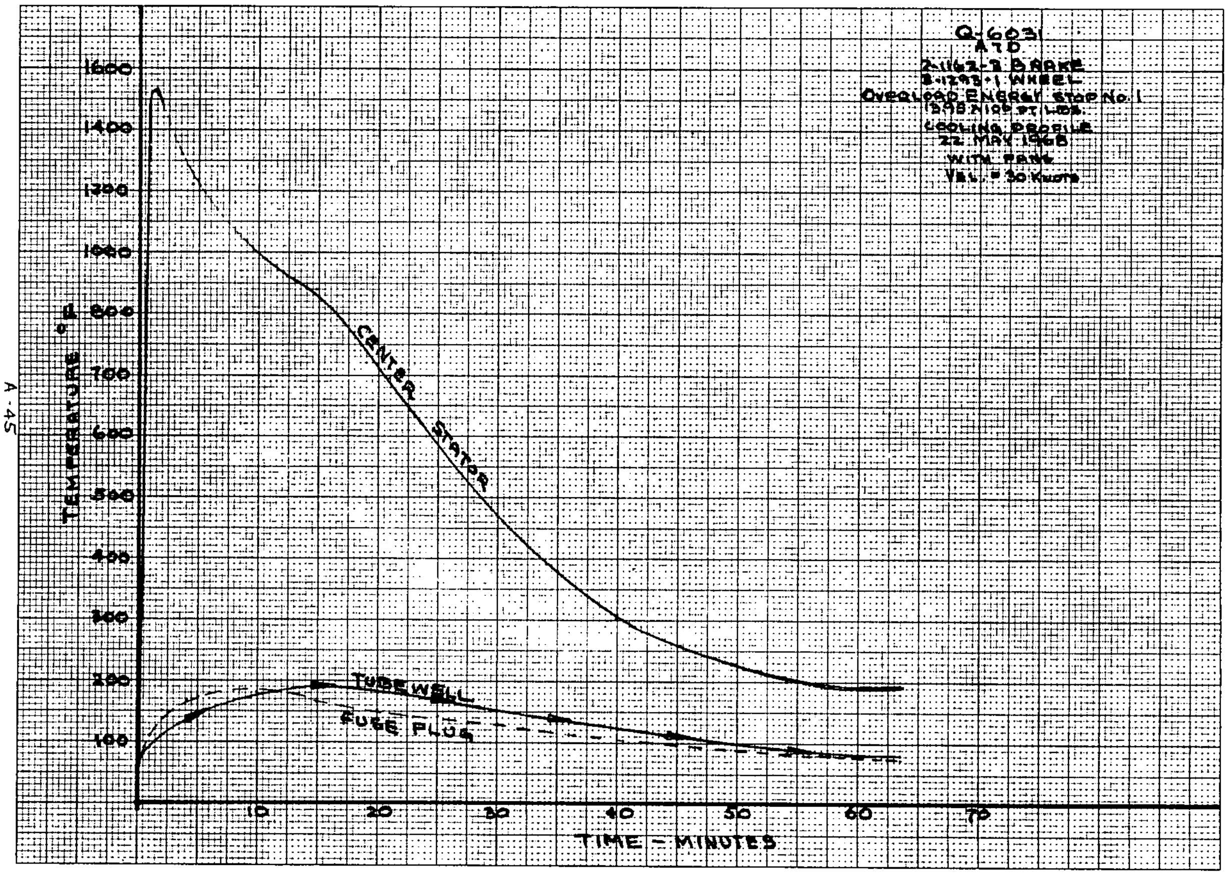

Q 6031
ATD
NORMAL ENERGY STOP NO. 35
COOLING PROFILE
WITH FANS
KNOTS
TEMPERATURE °F
1400
1200
1000
900
800
700
600
500
400
300
200
100
10
20
30
40
50
60
70
80
TIME – MINUTES
CENTER STATOR
PRESSURE PLATE
BEAD SEAT
FALSE AXLE


OVERLOAD ENERGY STOP NO. 1
TORQUE-PRESSURE vs TIME
22 MAY 1968
PRESSURE
TORQUE
PRESSURE - PSI
TORQUE - LB-FT. X 10
1200
1100
1000
900
800
700
600
500
400
300
200
100
2
4
6
8
10
12
14
16
18
20
22
24
26
TIME - SECONDS

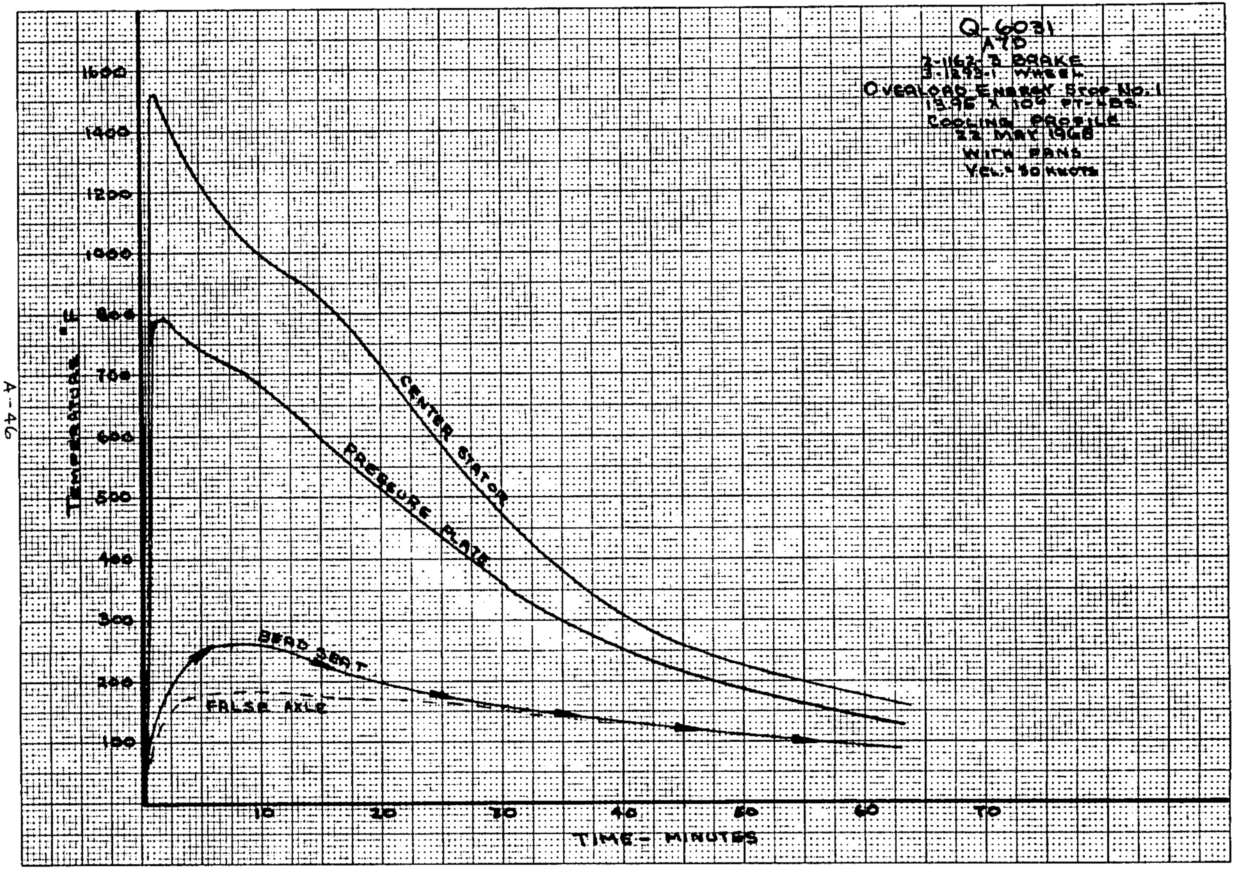


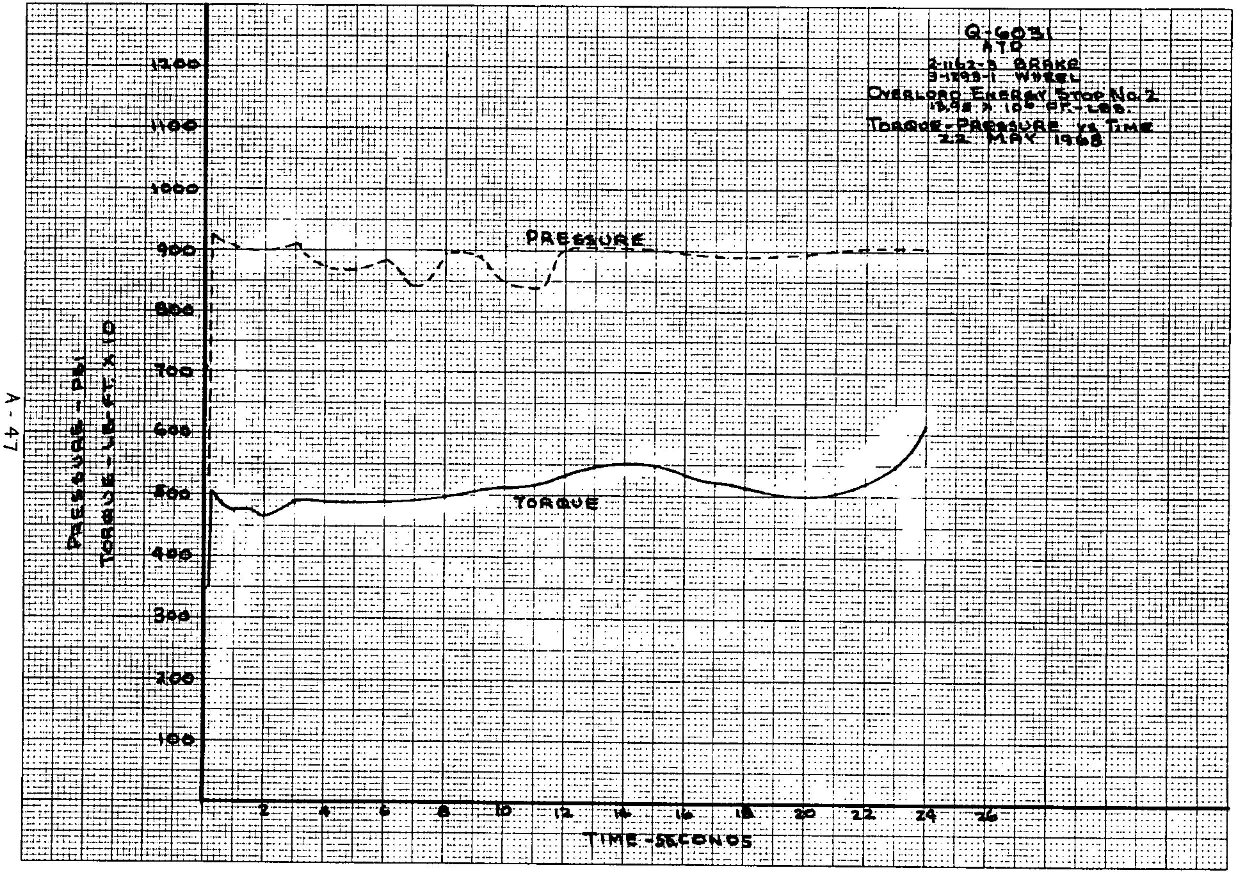
Q-6081
ATD
2-1162-3 BRAKE
3-1278-1 WHEEL
OVERLOAD ENERGY STOP No. 1
13.95 X 10^6 FT-LBS.
COOLING PROFILE
22 MAY 1968
WITH FANS
VEL. = 30 KNOTS
TEMPERATURE °F
1600
1400
1200
1000
800
700
600
500
400
300
200
100
#2 ROTOR
TORQUE PLATE
FLUID
PISTON HOUSING
10
20
30
40
50
60
70
TIME — MINUTES

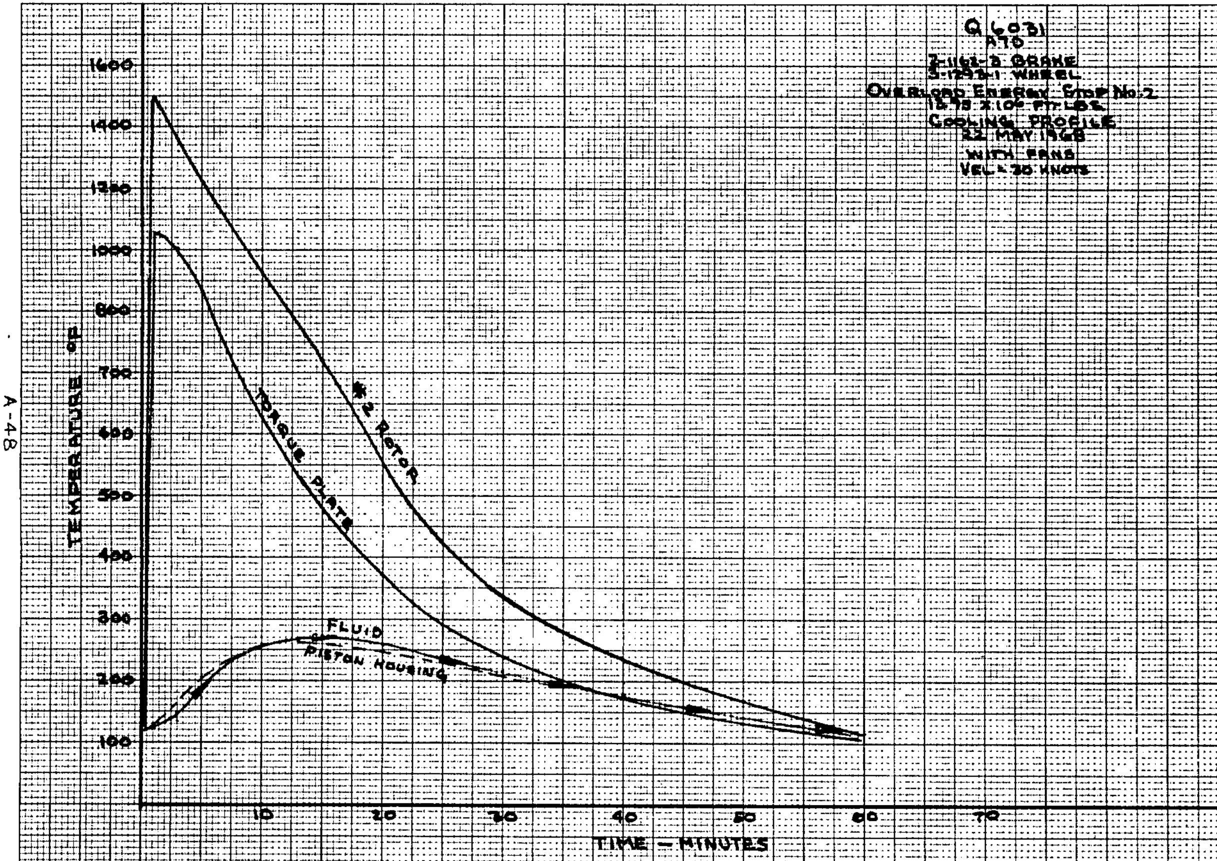
A-44


Q-6031
ATD
2-1162-2 BRAKE
3-1293-1 WHEEL
OVERLOAD ENERGY STOP No. 1
COOLING PROFILE
22 MAY 1968
WITH FANS
VEL. = 30 KNOTS
CENTER STATOR
TUBE WELL
FUSE PLUG
TEMPERATURE °F
1600
1400
1200
1000
800
700
600
500
400
300
200
100
10
20
30
40
50
60
70
TIME - MINUTES

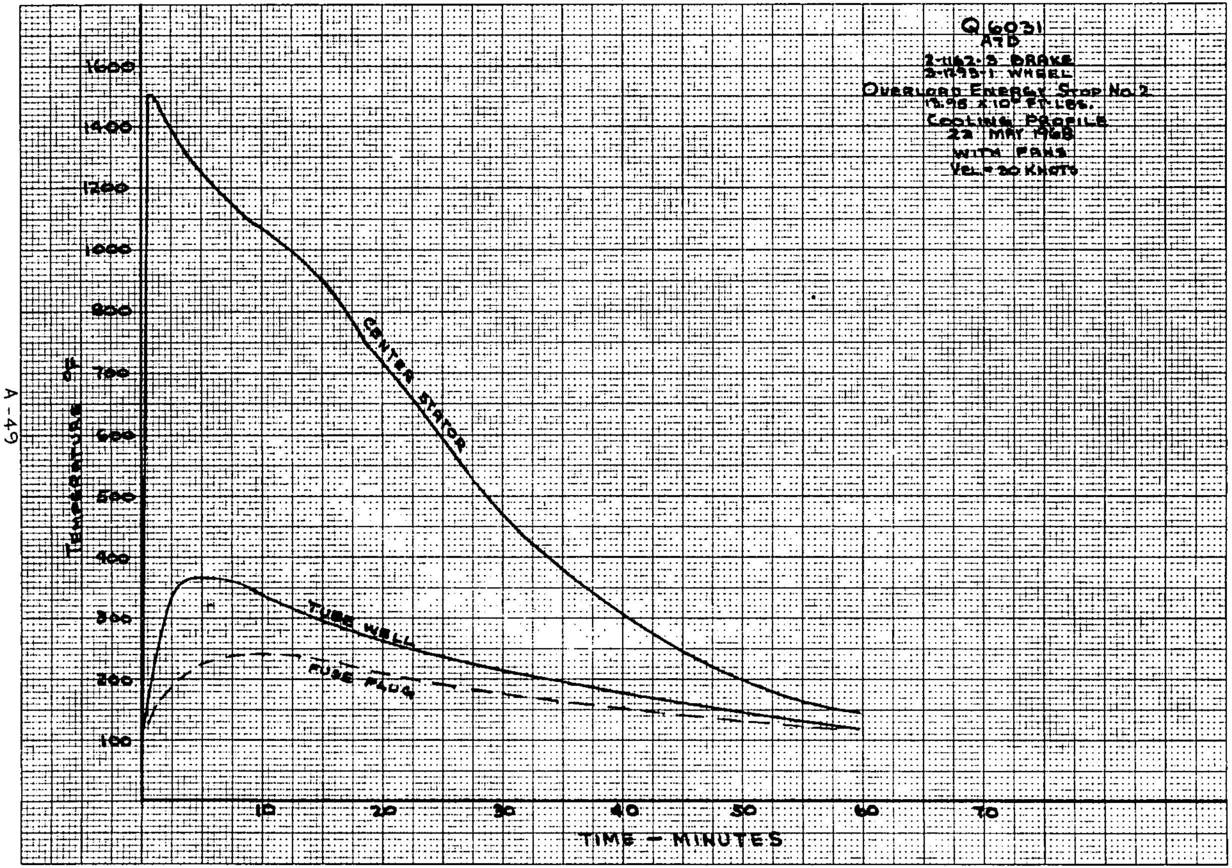
A-46


Q-6031
ATD
3-1162-3 BRAKE
3-1292-1 WHEEL
OVERLOAD ENERGY STOP NO. 1
13.95 X 10^6 FT-LBS.
COOLING PROFILE
22 MAY 1968
WITH FANS
VEL. 30 KNOTS
TEMPERATURE °F
1600
1400
1200
1000
800
700
600
500
400
300
200
100
CENTER STATOR
PRESSURE PLATE
BEAD SEAT
FALSE AXLE
10
20
30
40
50
60
70
TIME - MINUTES

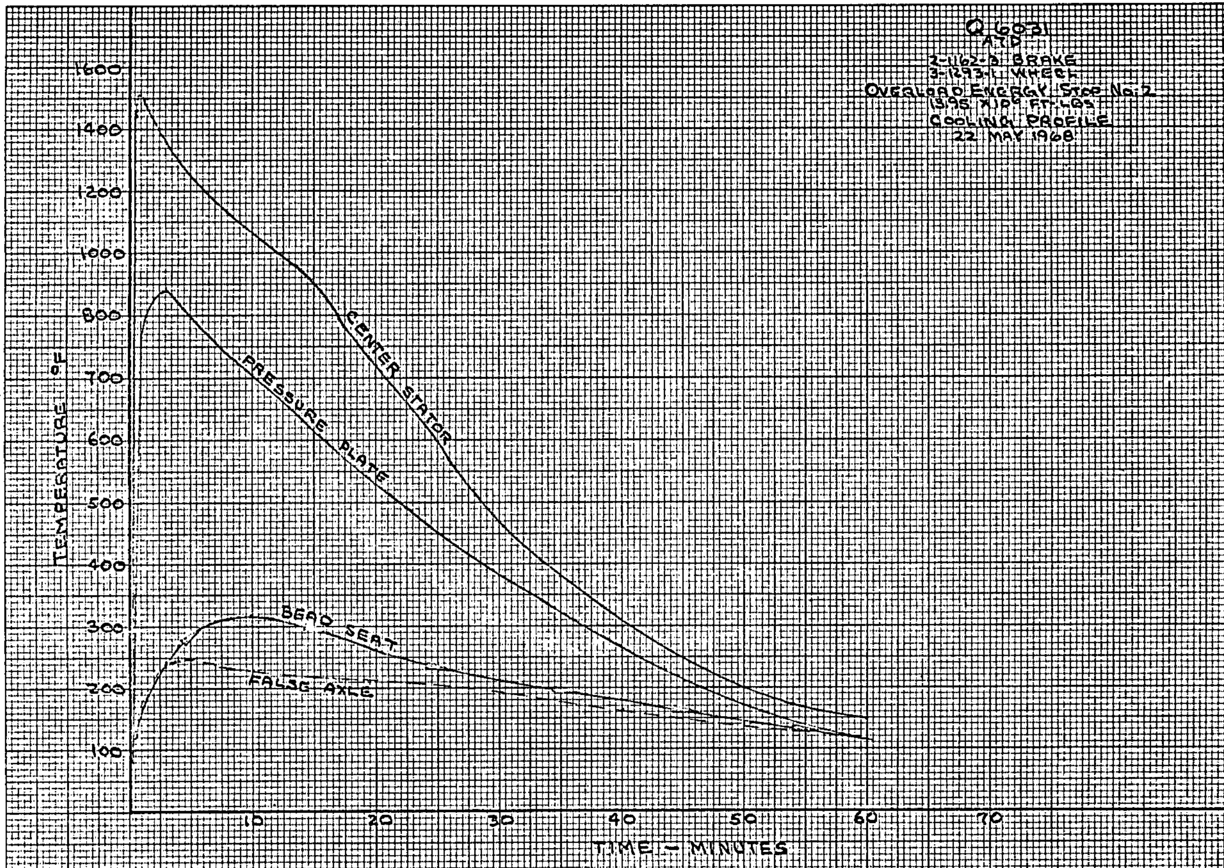

Q-6031
ATD
2-1162-3 BRAKE
3-1293-1 WHEEL
OVERLOAD ENERGY STOP No. 2
TORQUE-PRESSURE vs TIME
22 MAY 1968
PRESSURE
TORQUE
PRESSURE - PSI
TORQUE - LB-FT. x 10
1200
1100
1000
900
800
700
600
500
400
300
200
100
2
4
6
8
10
12
14
16
18
20
22
24
26
TIME - SECONDS

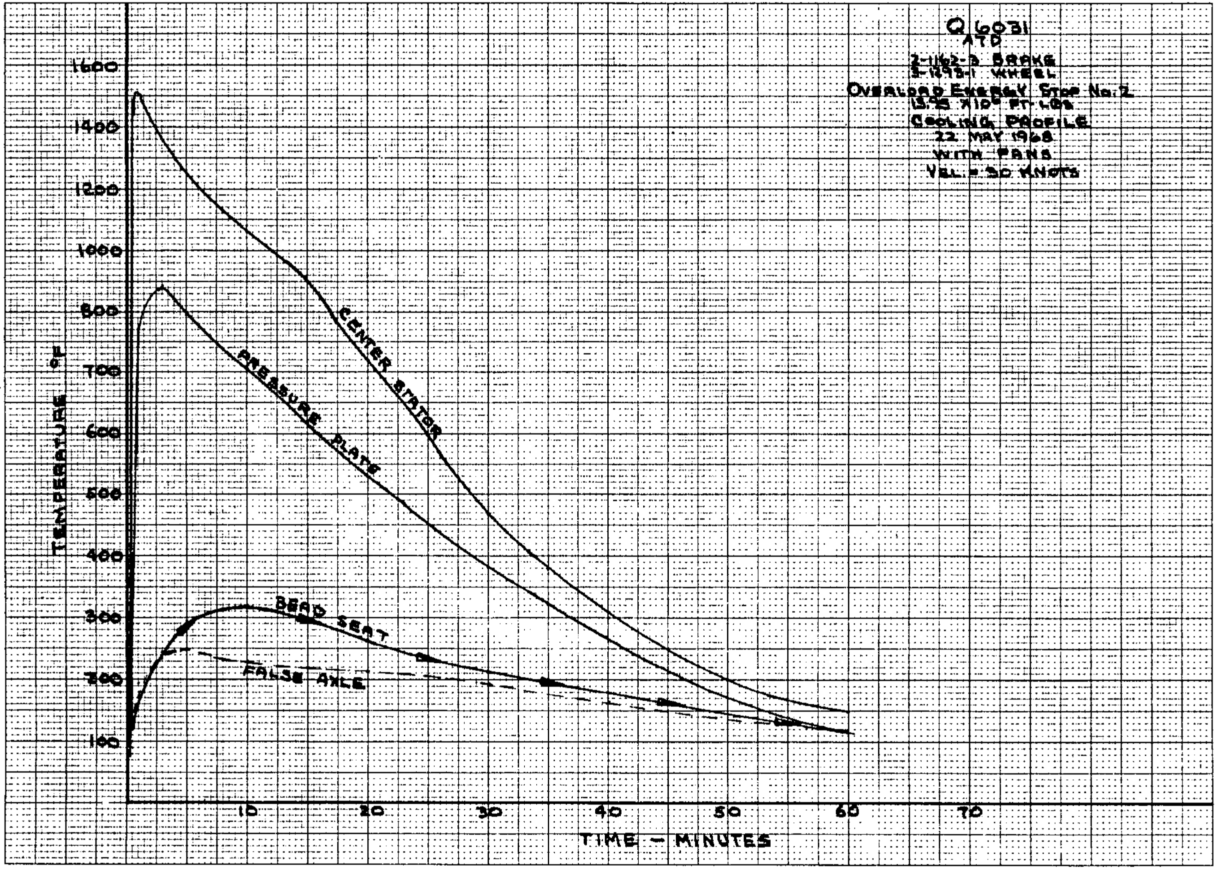


BRAKE
WHEEL
OVERLOAD ENERGY STOP No. 2
COOLING PROFILE
22 MAY 1968
WITH FANS
VEL = 30 KNOTS
TEMPERATURE °F
1600
1400
1200
1000
800
700
600
500
400
300
200
100
#2 ROTOR
TORQUE PLATE
FLUID
PISTON HOUSING
10
20
30
40
50
60
70
TIME — MINUTES

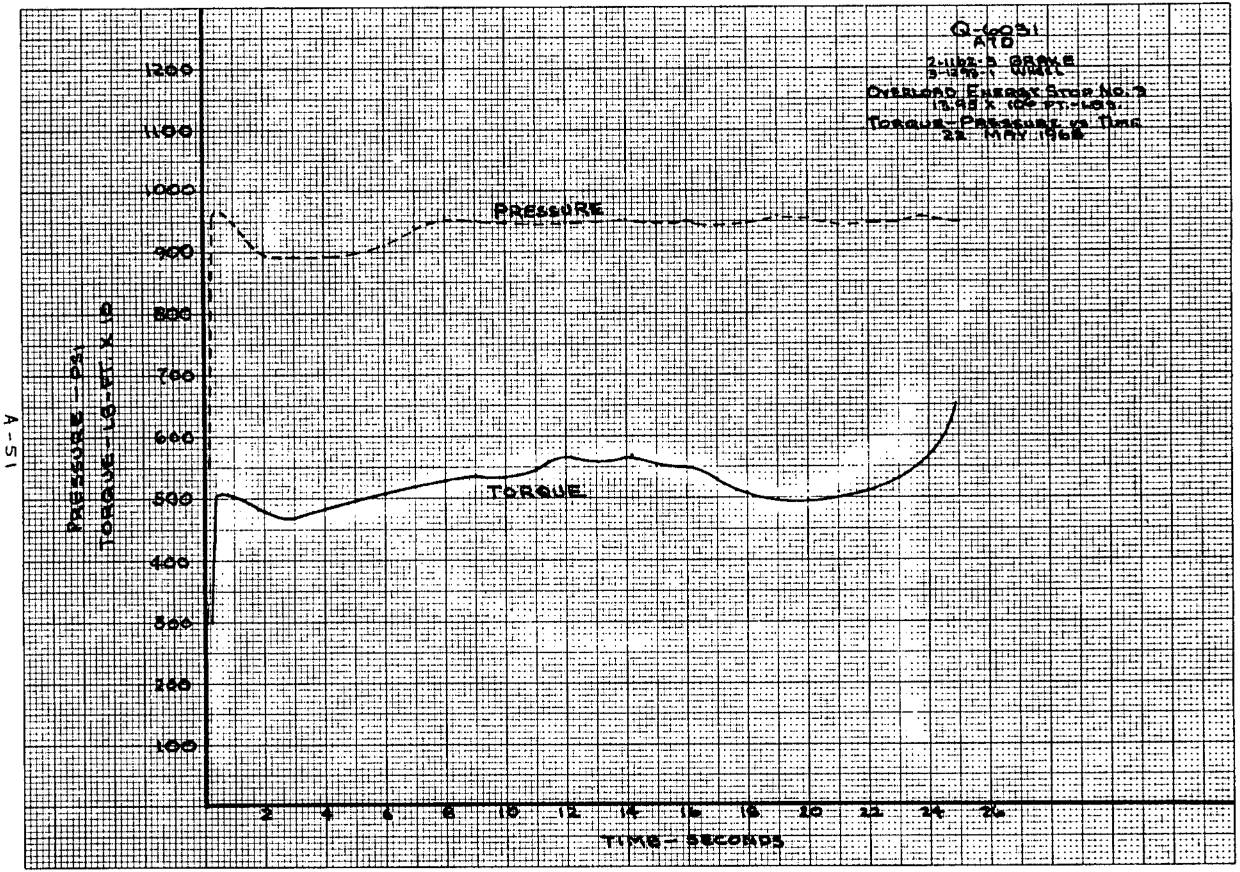

Q 6031
ATD
2-1162-3 BRAKE
2-1295-1 WHEEL
OVERLOAD ENERGY STOP No. 2
12.95 X 10 FT-LBS.
COOLING PROFILE
22 MAY 1968
WITH FANS
VEL = 20 KNOTS
TEMPERATURE °F
1600
1400
1200
1000
800
700
600
500
400
300
200
100
CENTER STATOR
TUBE WELL
FUSE PLUG
10
20
30
40
50
60
70
TIME — MINUTES

A-49

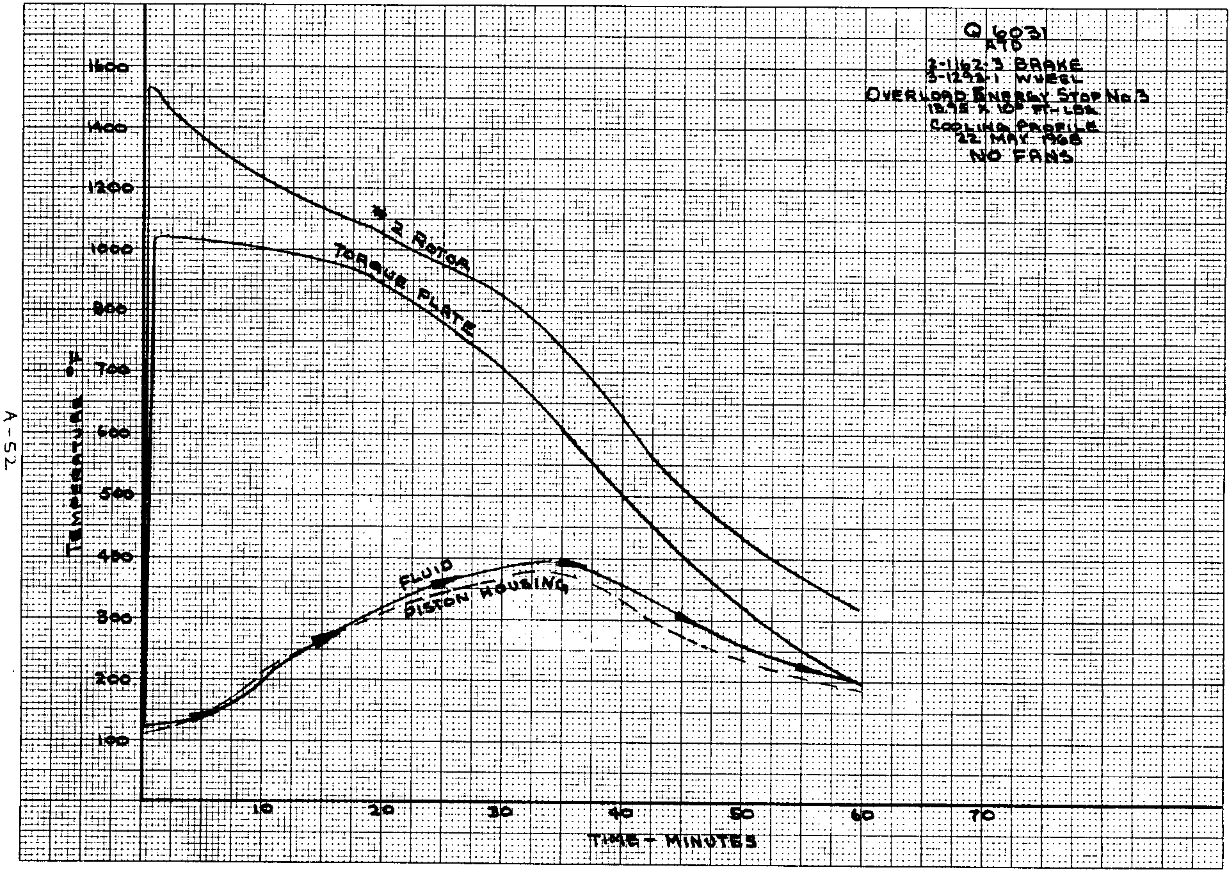

Q 6031
ATD
2-1162-3 BRAKE
3-1293-1 WHEEL
OVERLOAD ENERGY STOP No. 2
1595 X 10^6 FT-LBS
COOLING PROFILE
22 MAY 1968
TEMPERATURE °F
1600
1400
1200
1000
800
700
600
500
400
300
200
100
CENTER STATOR
PRESSURE PLATE
BEAD SEAT
FALSE AXLE
10
20
30
40
50
60
70
TIME — MINUTES



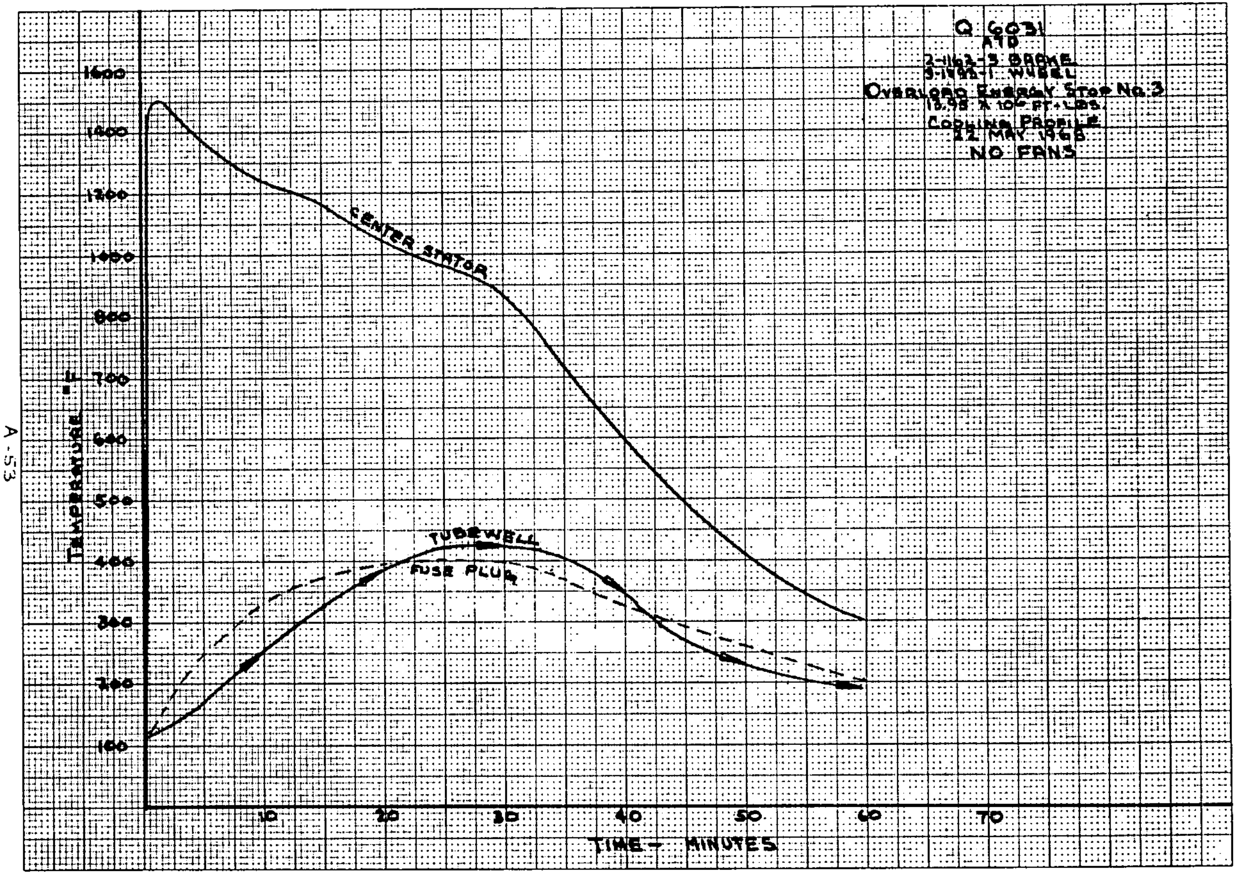
Q 6031
ATD
2-1162-3 BRAKE
WHEEL
OVERLOAD ENERGY STOP No. 2
COOLING PROFILE
22 MAY 1968
WITH FANS
VEL = 30 KNOTS
CENTER STATOR
PRESSURE PLATE
BEAD SEAT
FALSE AXLE
TEMPERATURE °F
1600
1400
1200
1000
800
700
600
500
400
300
200
100
10
20
30
40
50
60
70
TIME — MINUTES



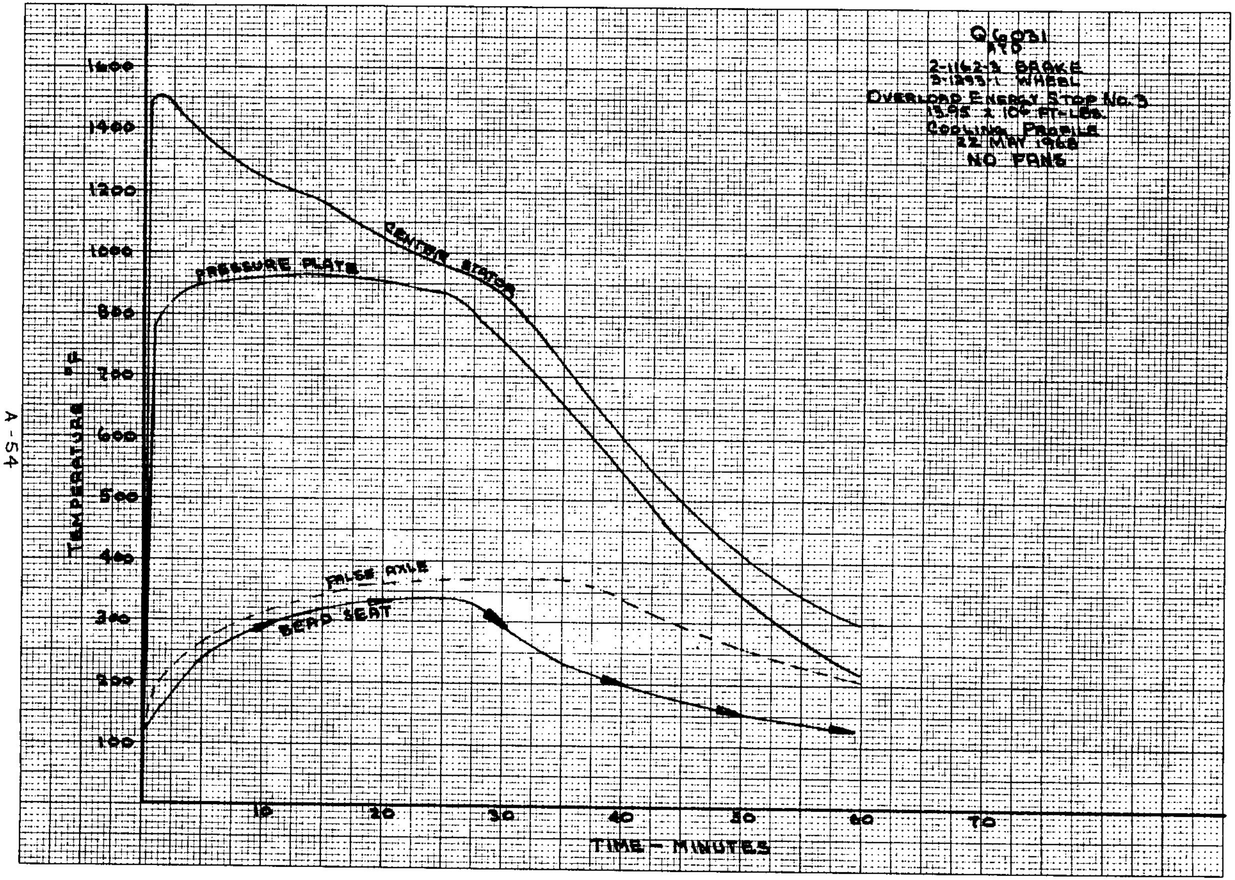
Q-6031
BRAKE
WHEEL
TORQUE — PRESSURE vs TIME
PRESSURE — PSI
TORQUE — LB-FT. X 10
1200
1100
1000
900
800
700
600
500
400
300
200
100
PRESSURE
TORQUE
2
4
6
8
10
12
14
16
18
20
22
24
26
TIME — SECONDS


Q 6031
ATD
2-1162-3 BRAKE
OVERLOAD ENERGY STOP No 3
COOLING PROFILE
NO FANS
#2 ROTOR
TORQUE PLATE
FLUID
PISTON HOUSING
TEMPERATURE °F
1600
1400
1200
1000
800
700
600
500
400
300
200
100
10
20
30
40
50
60
70
TIME – MINUTES

A-52


Q 6031
ATD
OVERLOAD ENERGY STOP No.3
22 MAY 1968
NO FANS
CENTER STATOR
TUBEWELL
FUSE PLUG
TEMPERATURE °F
1600
1400
1200
1000
800
700
600
500
400
300
200
100
10
20
30
40
50
60
70
TIME — MINUTES

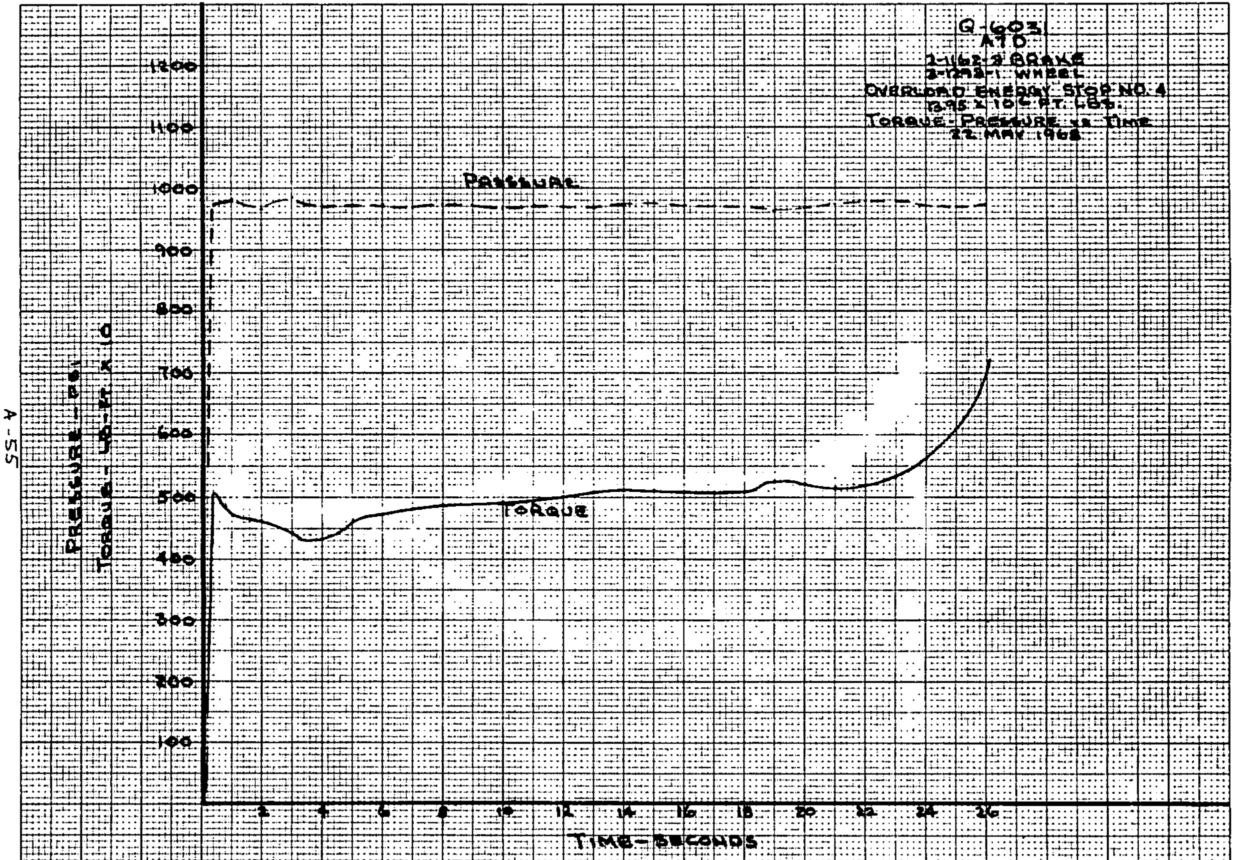
A-53

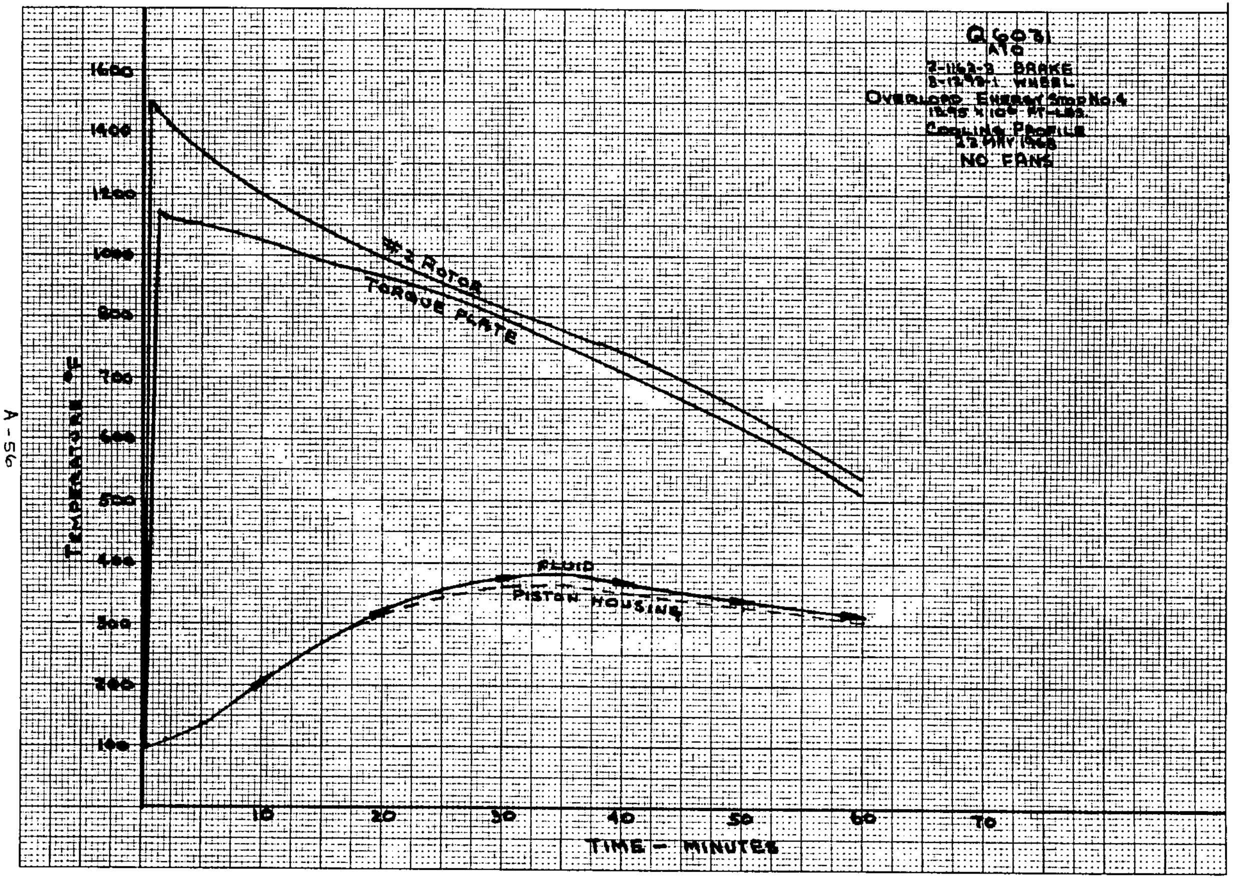


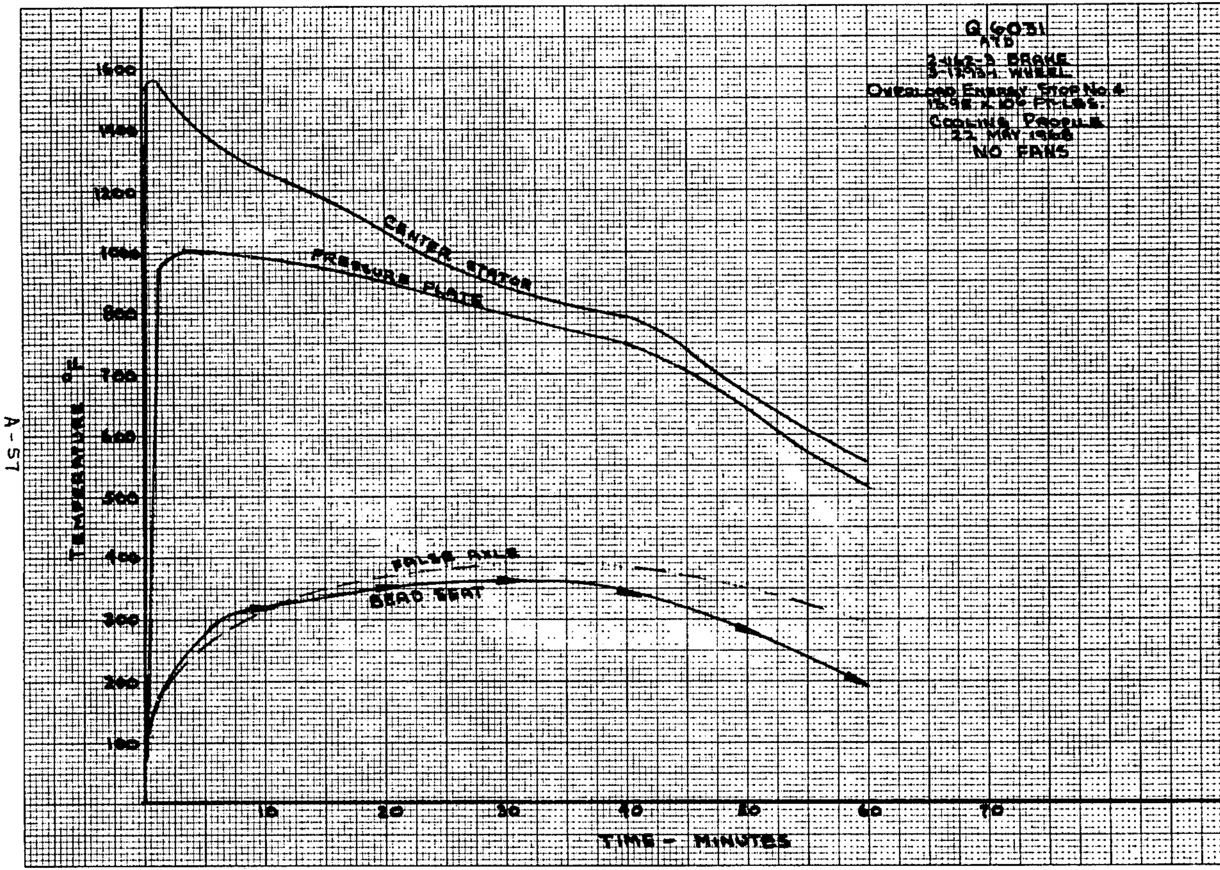
Q6031
ATD
2-1162-3 BRAKE
3-1293-1 WHEEL
OVERLOAD ENERGY STOP No. 3
13.95 x 10⁶ FT-LBS.
COOLING PROFILE
22 MAY 1968
NO FANS
TEMPERATURE °F
1600
1400
1200
1000
800
700
600
500
400
300
200
100
PRESSURE PLATE
CENTER STATOR
FALSE AXLE
BEAD SEAT
10
20
30
40
50
60
70
TIME — MINUTES

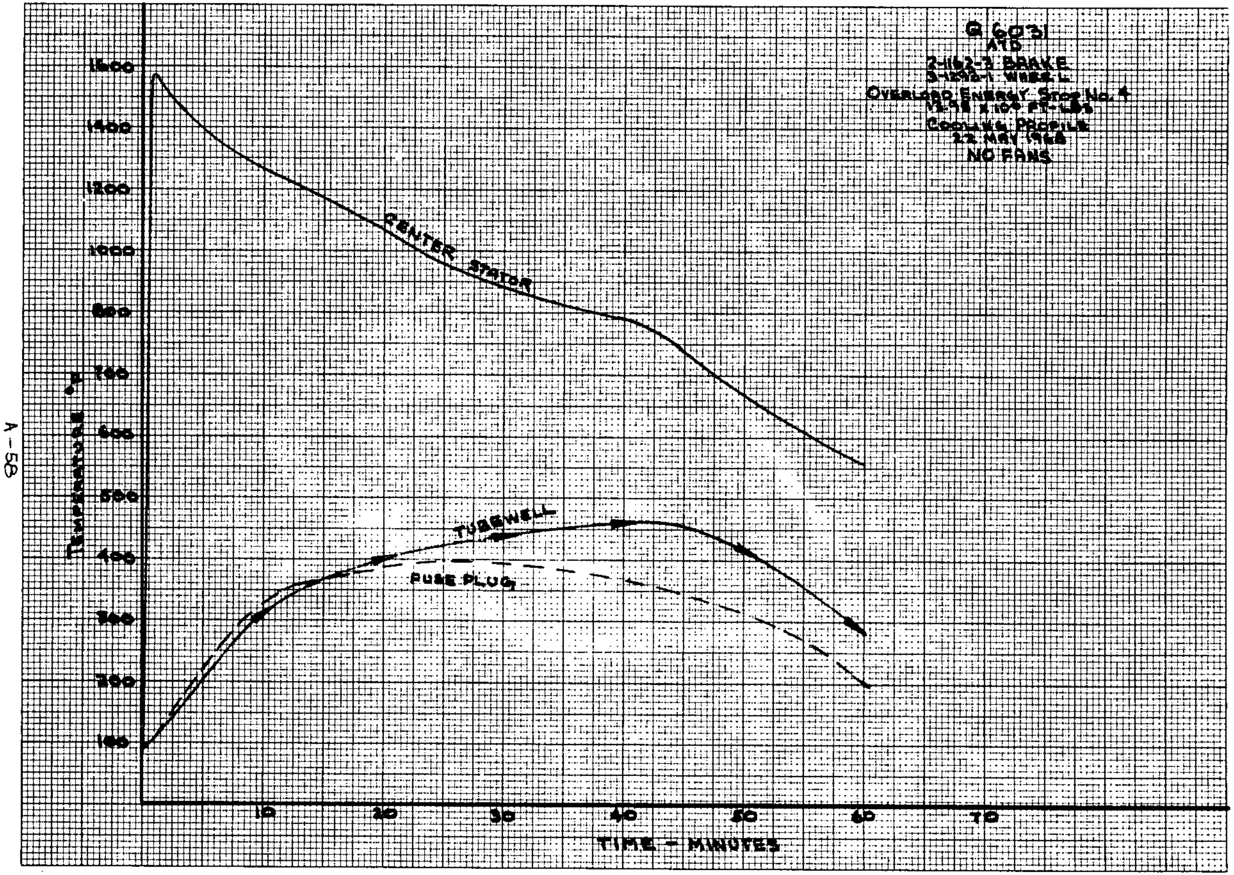
A-54

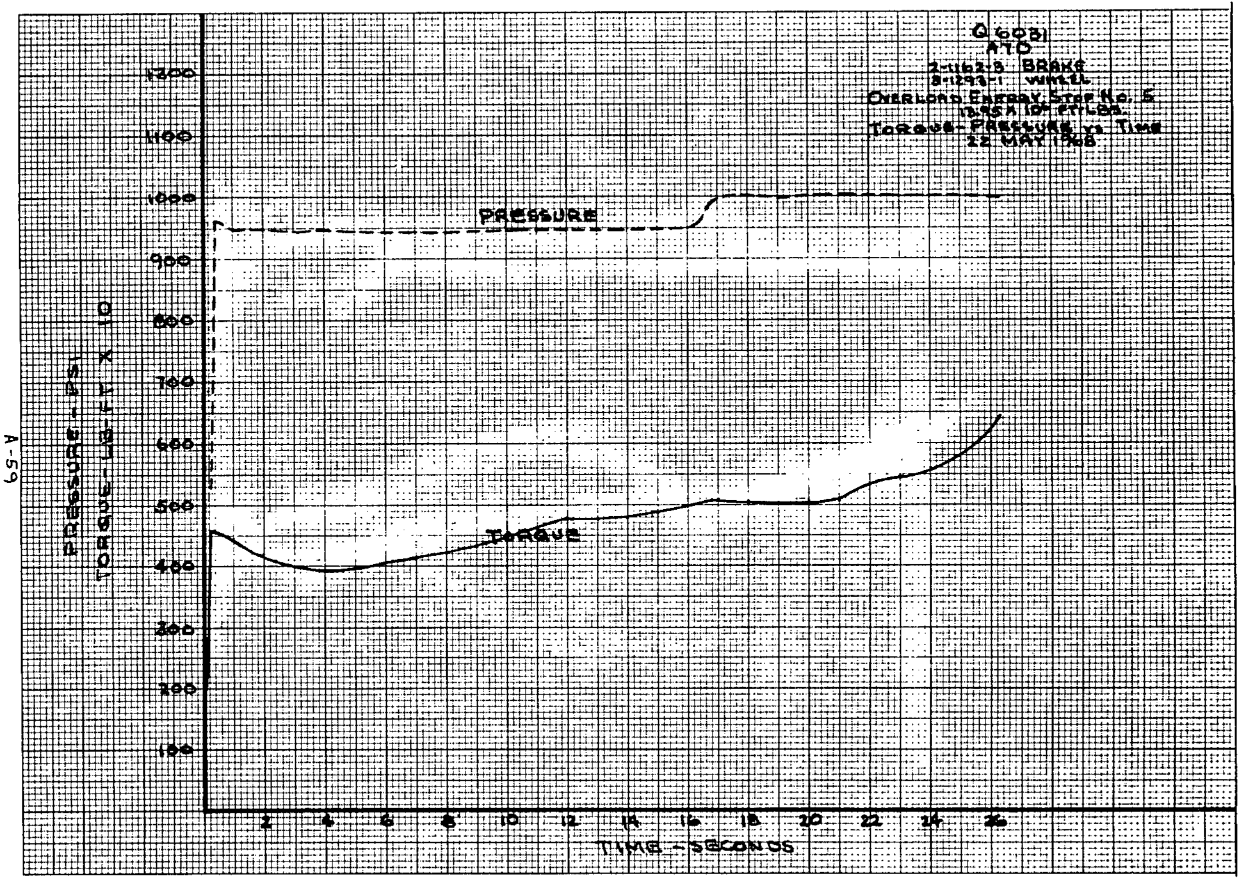
A-55


Q-6031
ATD
OVERLOAD ENERGY STOP NO. 4
TORQUE-PRESSURE vs TIME
22 MAY 1968
PRESSURE
TORQUE
PRESSURE - PSI
TORQUE - LB-FT. x 10
1200
1100
1000
900
800
700
600
500
400
300
200
100
2
4
6
8
10
12
14
16
18
20
22
24
26
TIME - SECONDS


BRAKE
WHEEL
OVERLOAD ENERGY STOP No. 4
COOLING PROFILE
NO FANS
1600
1400
1200
1000
800
700
600
500
400
300
200
100
TEMPERATURE °F
#2 ROTOR
TORQUE PLATE
FLUID
PISTON HOUSING
10
20
30
40
50
60
70
TIME — MINUTES


Q 6031
ATD
COOLING PROFILE
NO FANS
CENTER STATOR
PRESSURE PLATE
FALSE AXLE
BEAD SEAT
TEMPERATURE °F
1600
1400
1200
1000
800
700
600
500
400
300
200
100
10
20
30
40
50
60
70
TIME - MINUTES

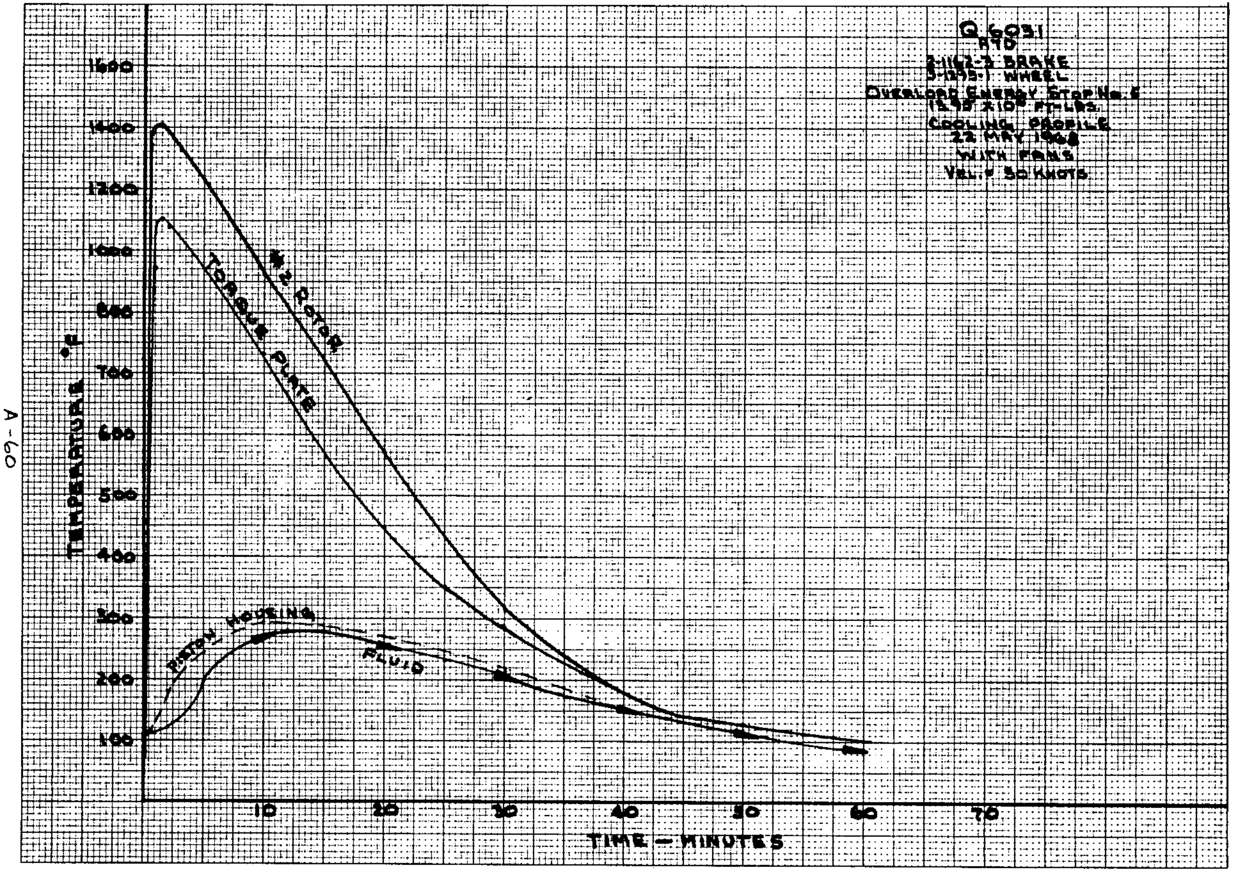

G 6031
ATD
2-1162-3 BRAKE
3-1292-1 WHEEL
OVERLOAD ENERGY STOP No. 4
COOLING PROFILE
22 MAY
NO FANS
CENTER STATOR
TUBEWELL
FUSE PLUG
TEMPERATURE °F
1600
1400
1200
1000
800
700
600
500
400
300
200
100
10
20
30
40
50
60
70
TIME – MINUTES

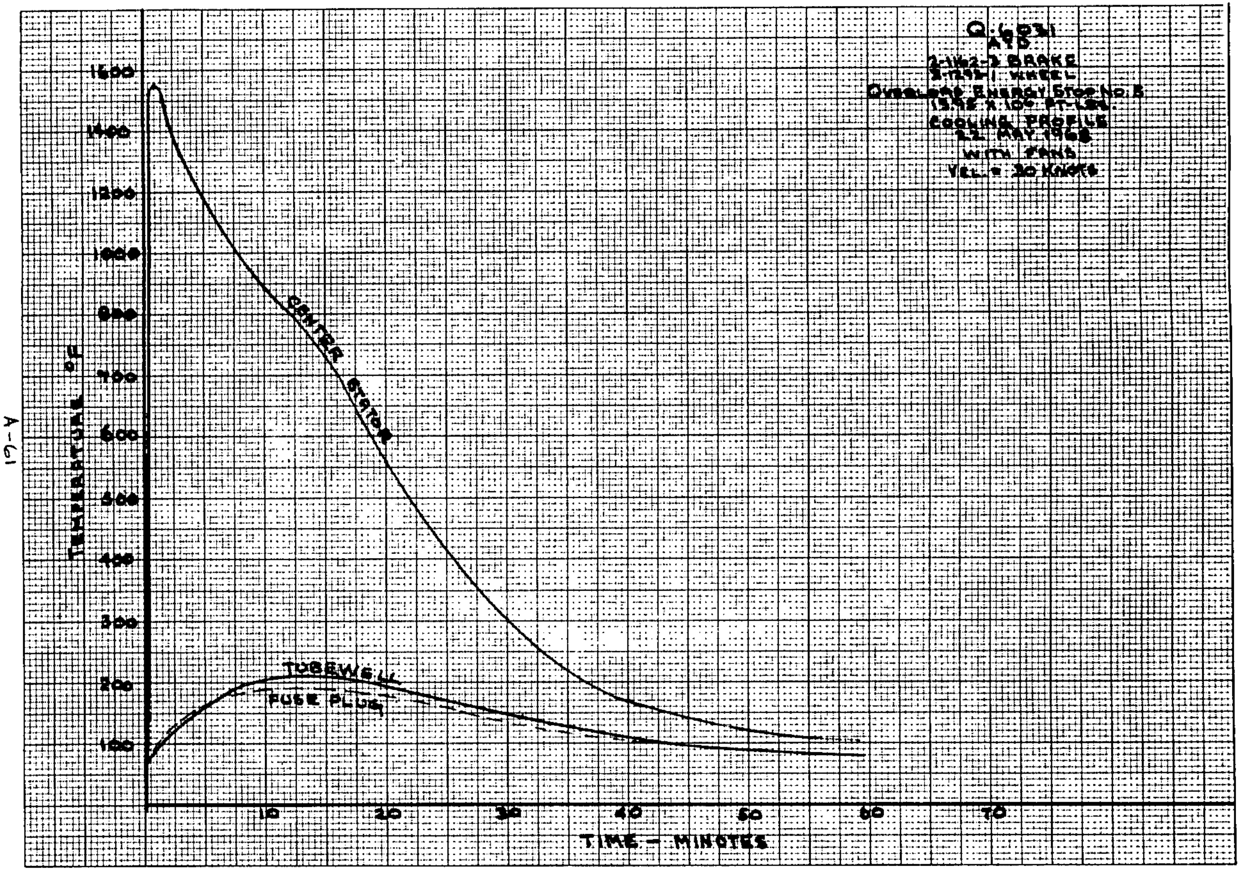


ATD
BRAKE
WHEEL
OVERLOAD ENERGY, STOP No. 5
TORQUE-PRESSURE vs TIME
22 MAY 1968
PRESSURE
TORQUE
PRESSURE - PSI
TIME - SECONDS

A-59

A-60

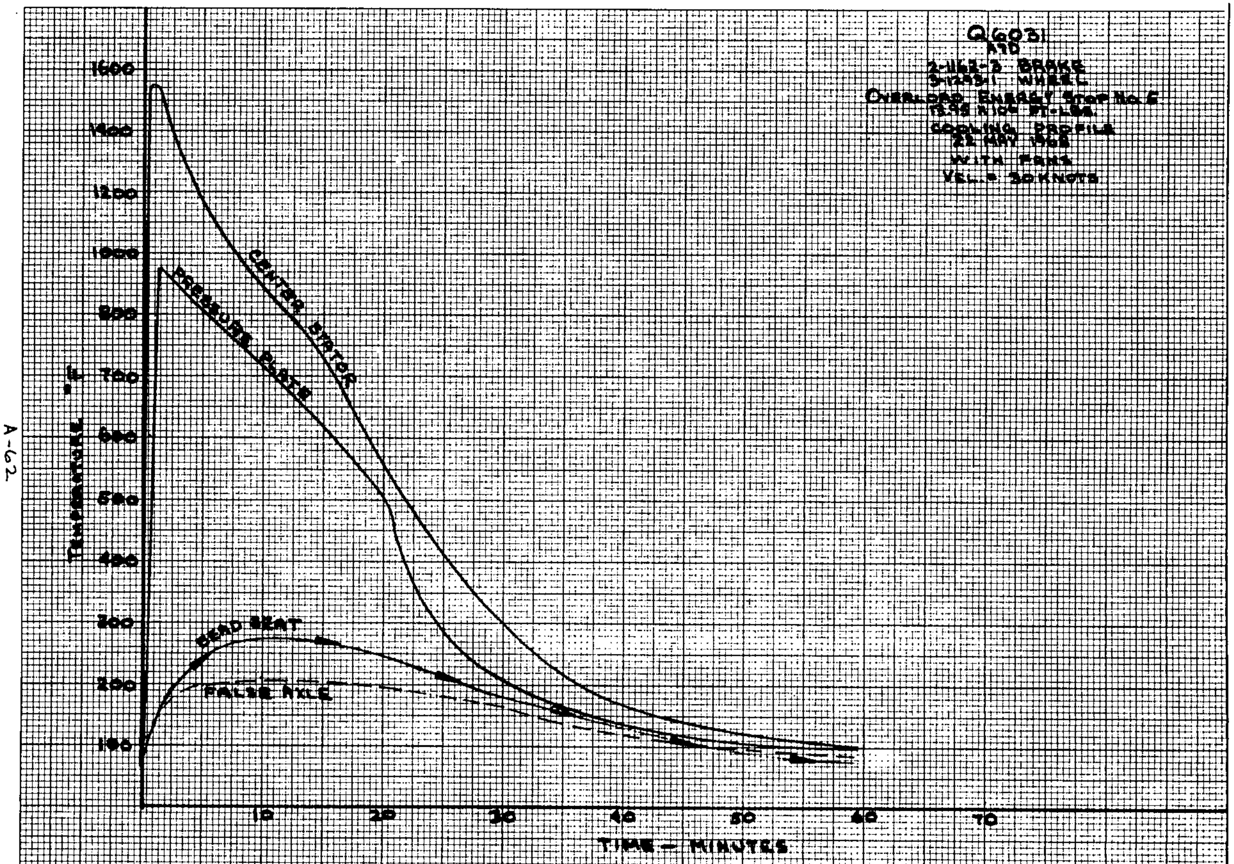

Q 6031
ATD
2-1162-3 BRAKE
3-1295-1 WHEEL
OVERLOAD ENERGY STOP No. 6
15.95 X 10⁶ FT-LBS.
COOLING PROFILE
22 MAY 1968
WITH FANS
VEL. = 50 KNOTS
TEMPERATURE °F
1600
1400
1200
1000
800
700
600
500
400
300
200
100
#2 ROTOR
TORQUE PLATE
PISTON HOUSING
FLUID
10
20
30
40
50
60
70
TIME — MINUTES



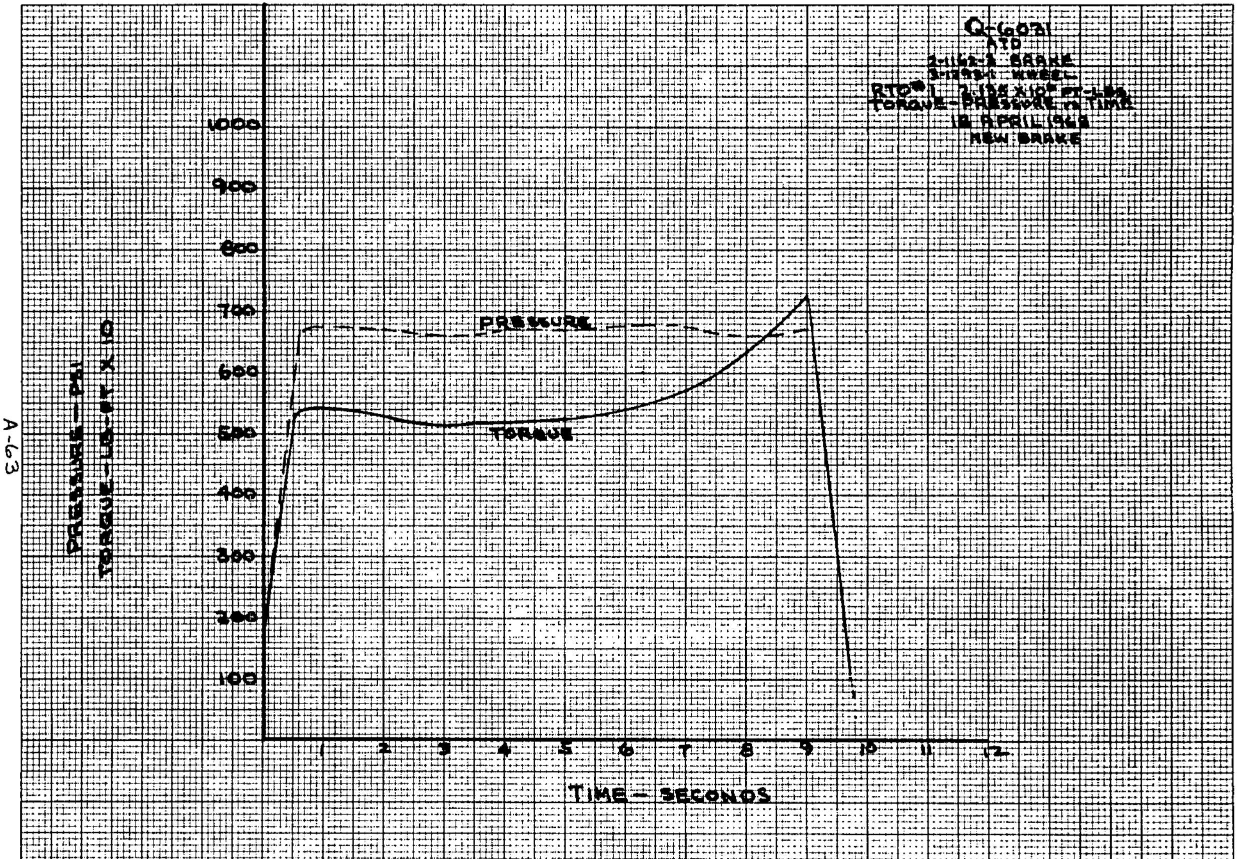
BRAKE
WHEEL
COOLING PROFILE
WITH FANS
VEL. = 20 KNOTS
1600
1400
1200
1000
800
700
600
500
400
300
200
100
TEMPERATURE °F
CENTER STATOR
FUSE PLUG
10
20
30
40
50
60
70
TIME — MINUTES

A-61

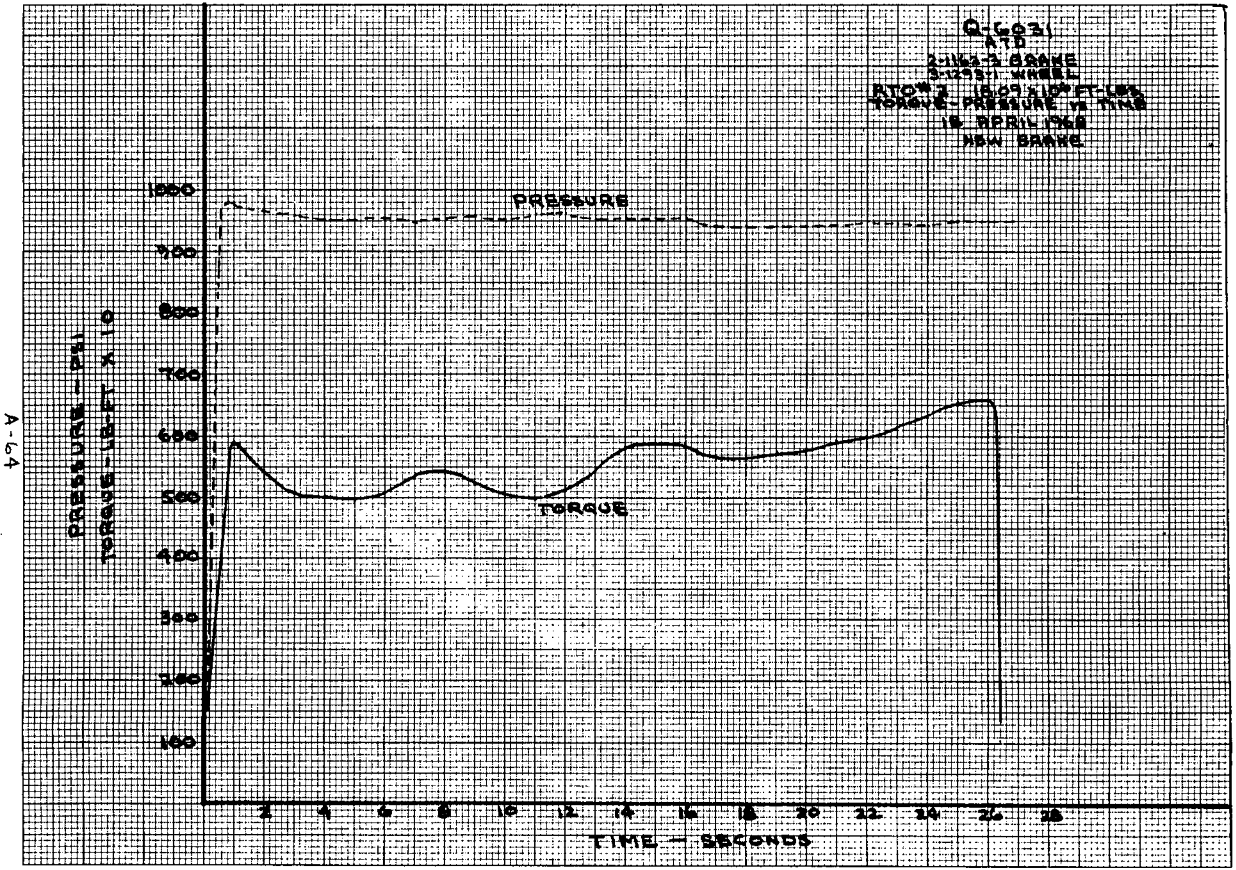
115


Q6031
BRAKE
WHEEL
OVERLOAD ENERGY STOP No. 6
COOLING PROFILE
WITH FANS
VEL. = 30 KNOTS
TEMPERATURE °F
1600
1400
1200
1000
800
700
600
500
400
300
200
100
CENTER STATOR
PRESSURE PLATE
BEAD SEAT
FALSE AXLE
10
20
30
40
50
60
70
TIME — MINUTES

A-63

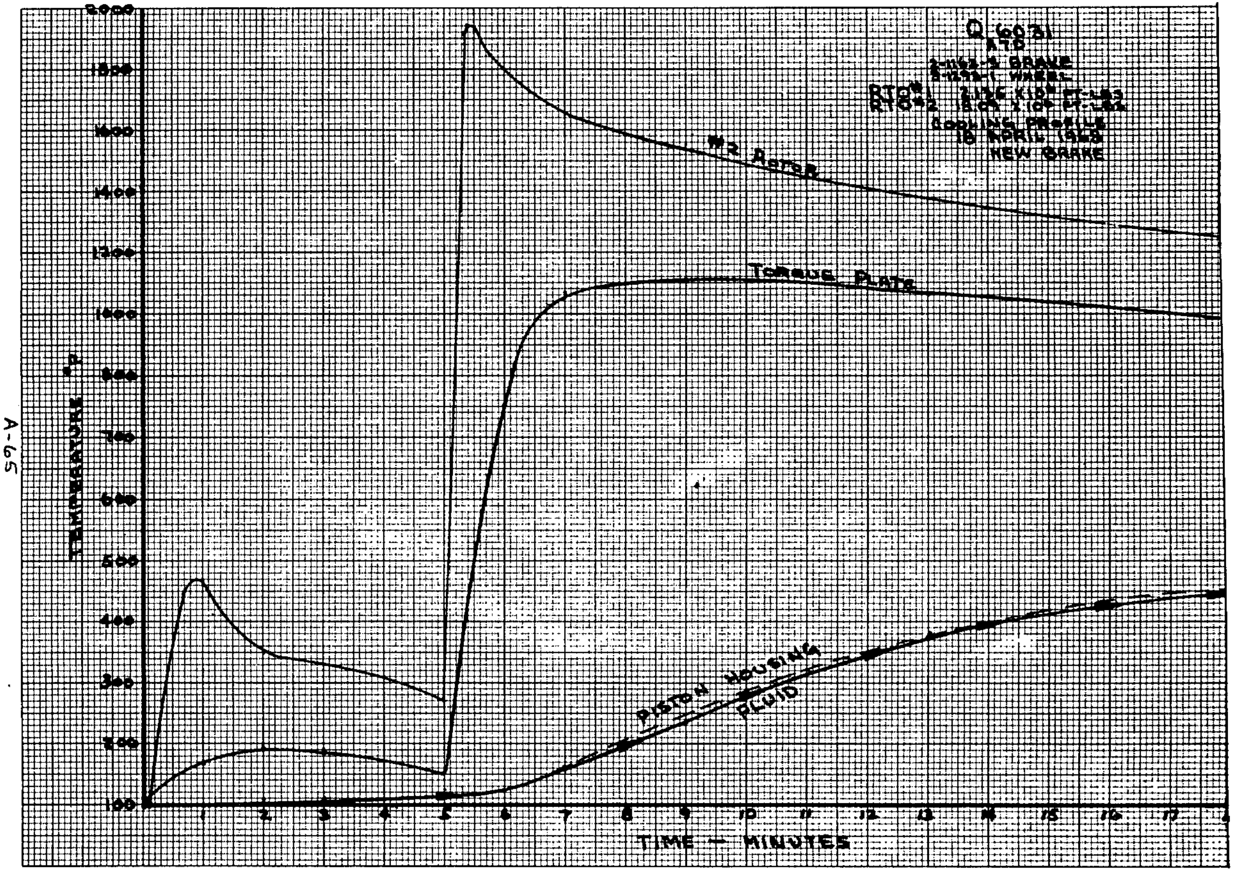


Q-6021
2-1162-2 BRAKE
3-1299-1 WHEEL
TORQUE-PRESSURE vs TIME
NEW BRAKE
PRESSURE
TORQUE
PRESSURE — PSI
TORQUE-LB-FT X 10
1000
900
800
700
600
500
400
300
200
100
1
2
3
4
5
6
7
8
9
10
11
12
TIME — SECONDS

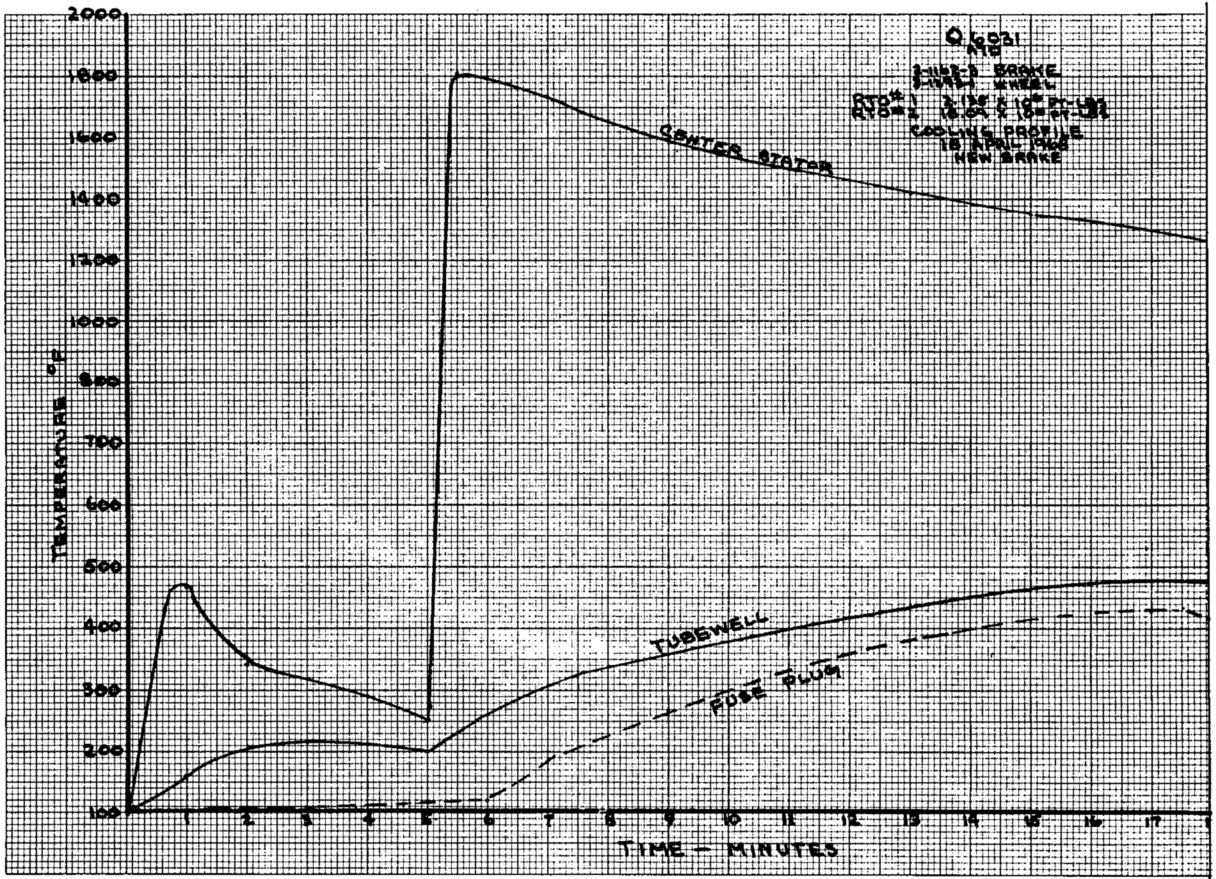

ATD
BRAKE
WHEEL
TORQUE-PRESSURE vs TIME
APRIL
NEW BRAKE
PRESSURE
TORQUE
PRESSURE — PSI
TORQUE-LB-FT X 10
1000
900
800
700
600
500
400
300
200
100
2
4
6
8
10
12
14
16
18
20
22
24
26
28
TIME — SECONDS

A-64

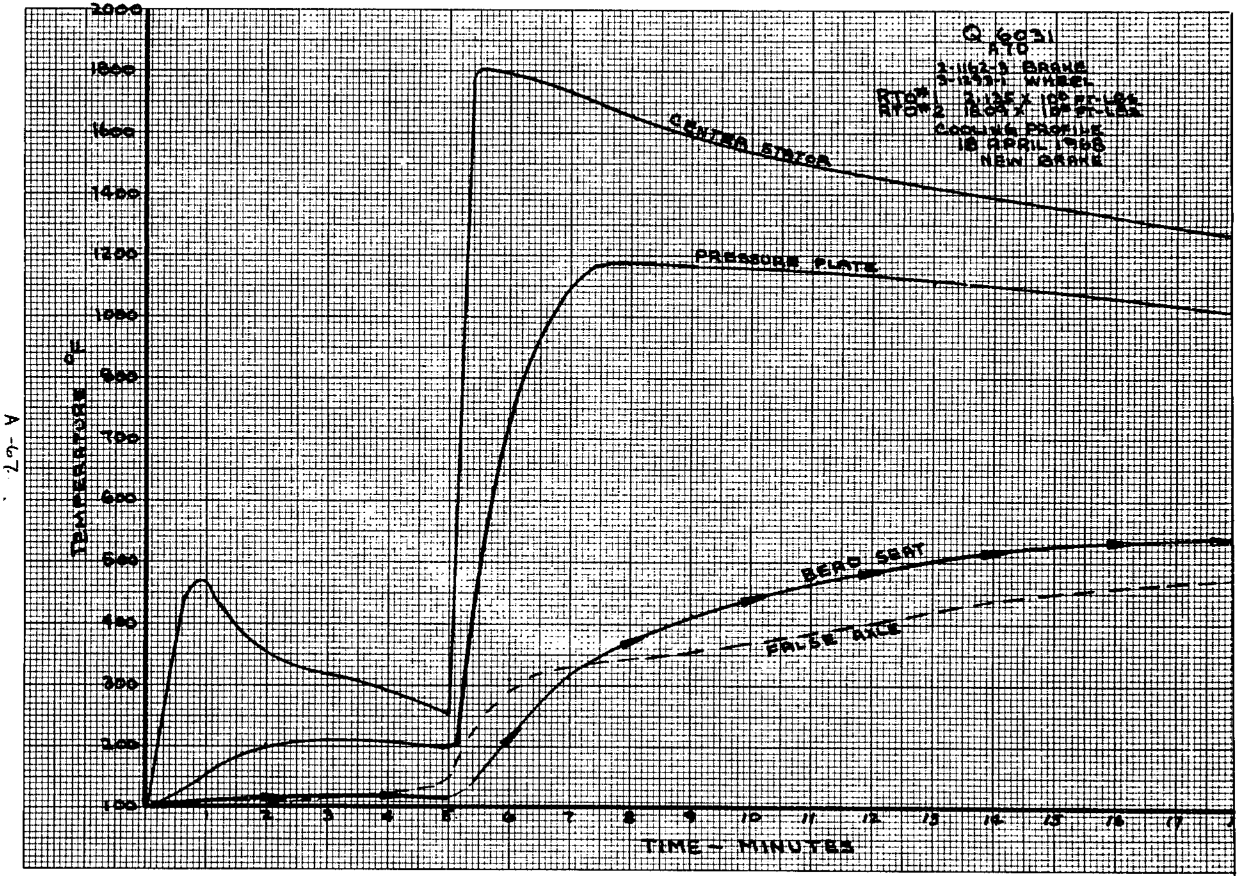
A-65



BRAKE
WHEEL
COOLING PROFILE
NEW BRAKE
#2 ROTOR
TORQUE PLATE
PISTON HOUSING
FLUID
TEMPERATURE °F
TIME — MINUTES
2000
1800
1600
1400
1200
1000
800
700
600
500
400
300
200
100
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17

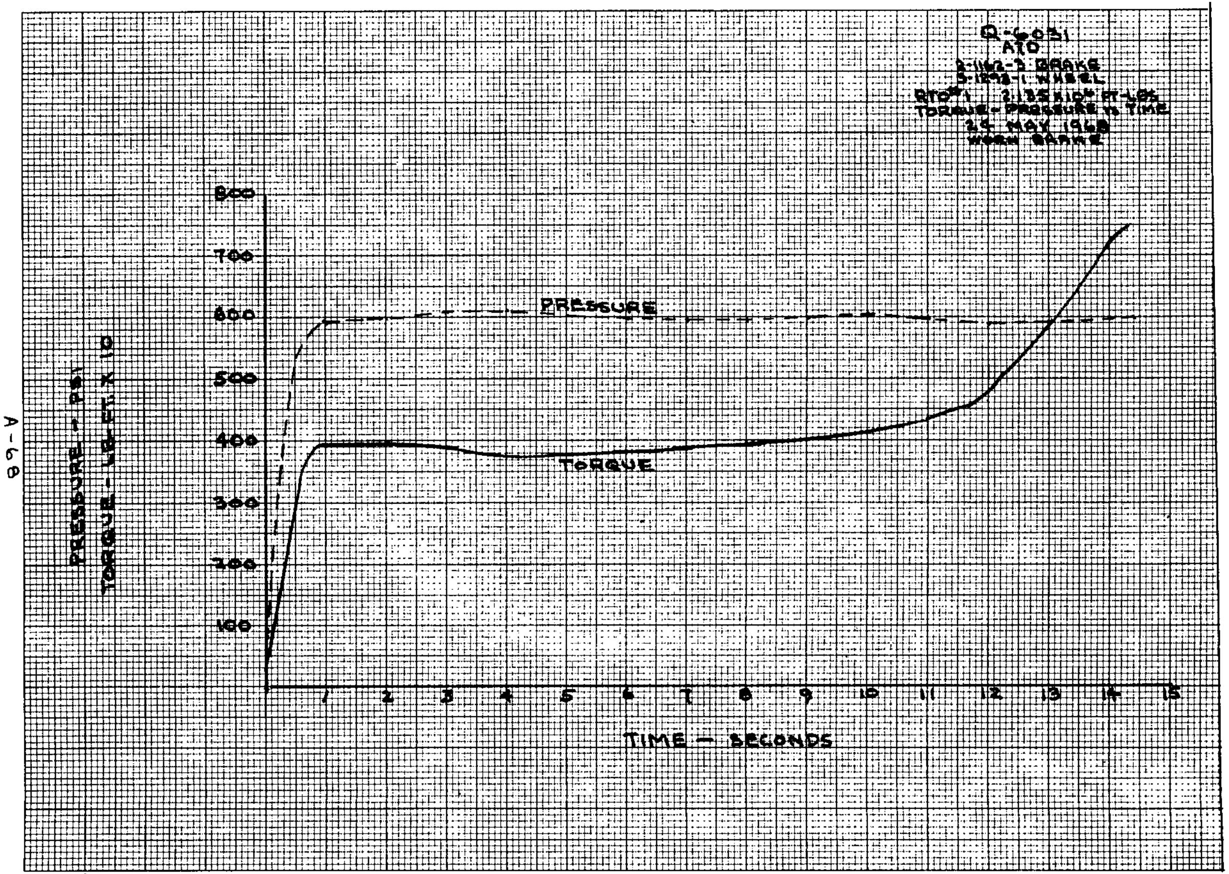

Q 6031
BRAKE
WHEEL
COOLING PROFILE
18 APRIL 1968
NEW BRAKE
CENTER STATOR
TUBEWELL
FUSE PLUG
TEMPERATURE °F
2000
1800
1600
1400
1200
1000
800
700
600
500
400
300
200
100
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
TIME — MINUTES

A-66

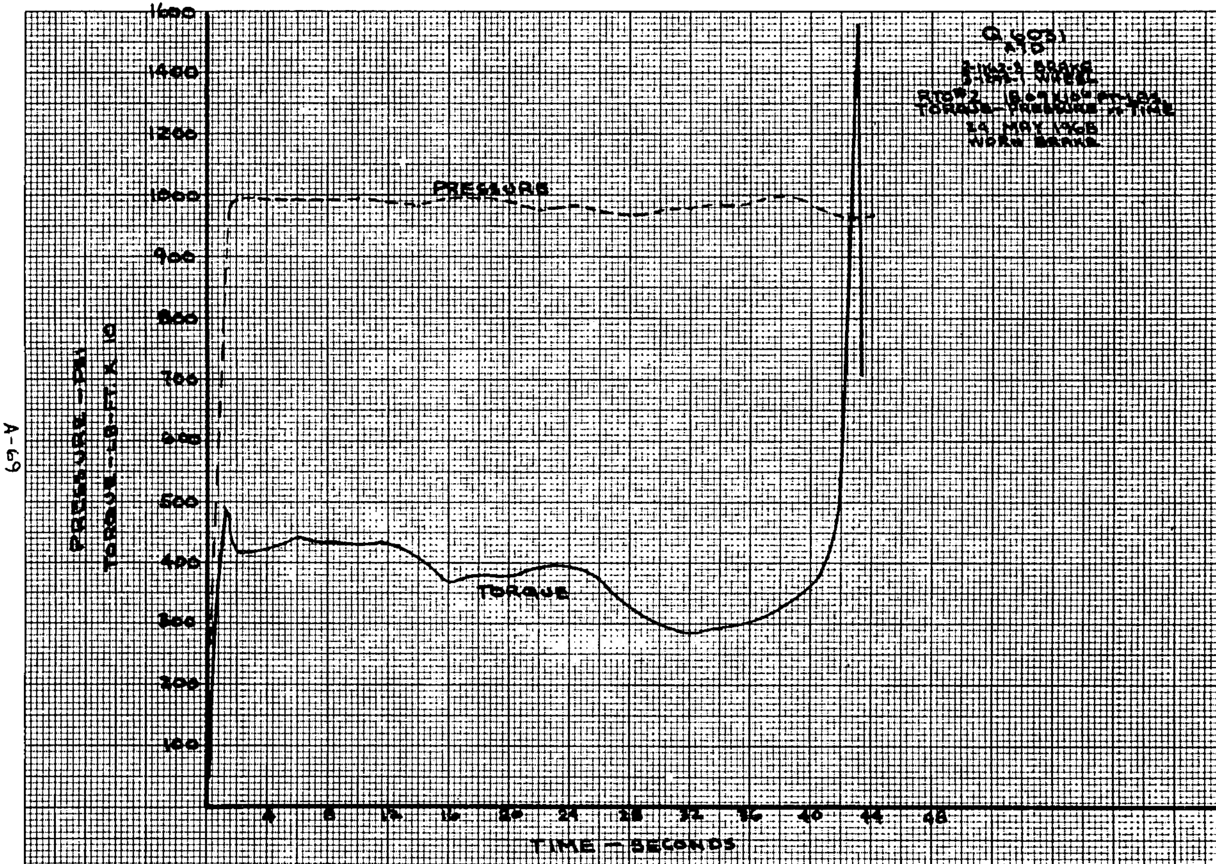


Q 6031
RTO
COOLING PROFILE
18 APRIL 1968
NEW BRAKE
CENTER STATOR
PRESSURE PLATE
BEAD SEAT
FALSE AXLE
TEMPERATURE °F
TIME — MINUTES

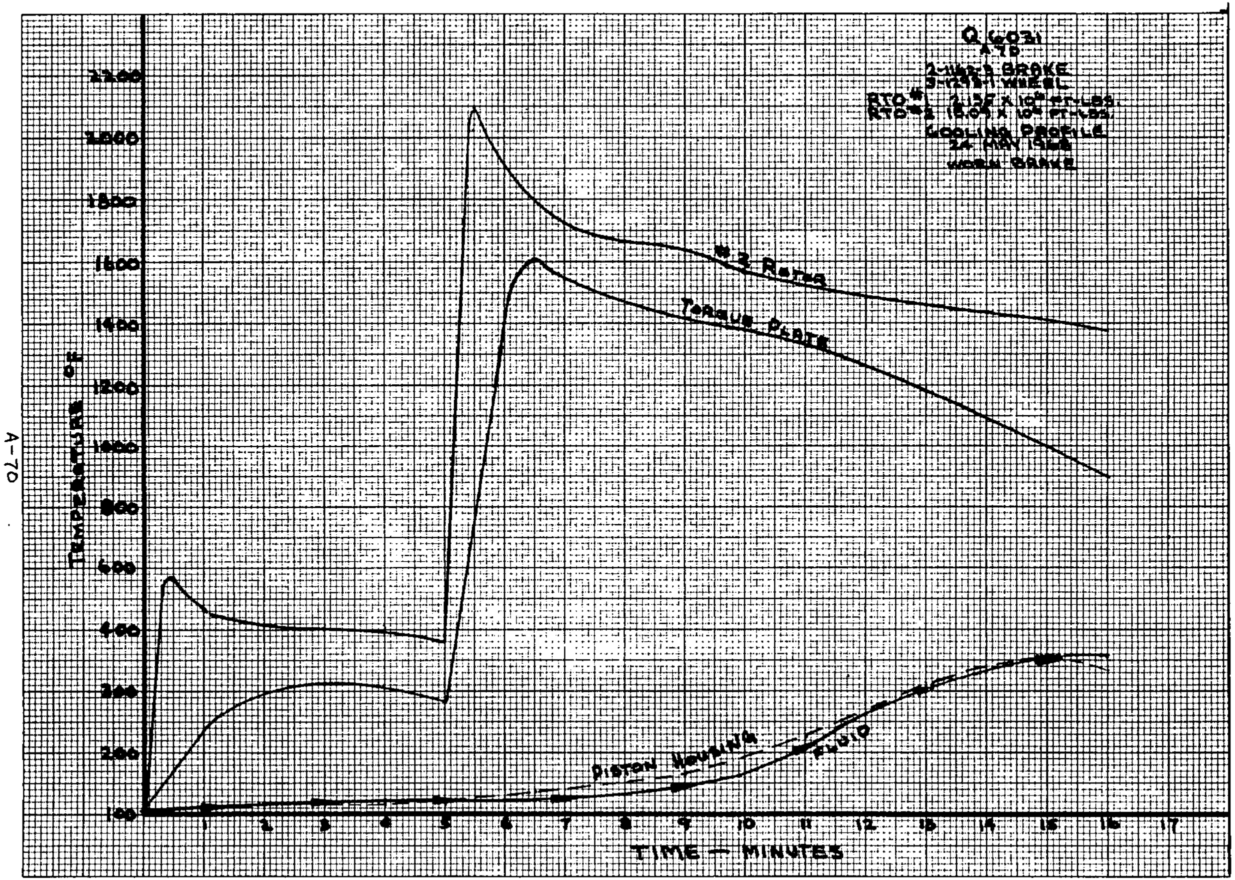
A-67


Q-6031
ATO
BRAKE
WHEEL
TORQUE - PRESSURE vs TIME
MAY
PRESSURE
TORQUE
PRESSURE - PSI
TORQUE - LB-FT. X 10
800
700
600
500
400
300
200
100
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
TIME — SECONDS

A-68


PRESSURE
TORQUE
PRESSURE — PSI
TORQUE — LB-FT X 10
1600
1400
1200
1000
900
800
700
500
400
300
200
100
4
8
12
16
20
24
28
32
36
40
44
48
TIME — SECONDS

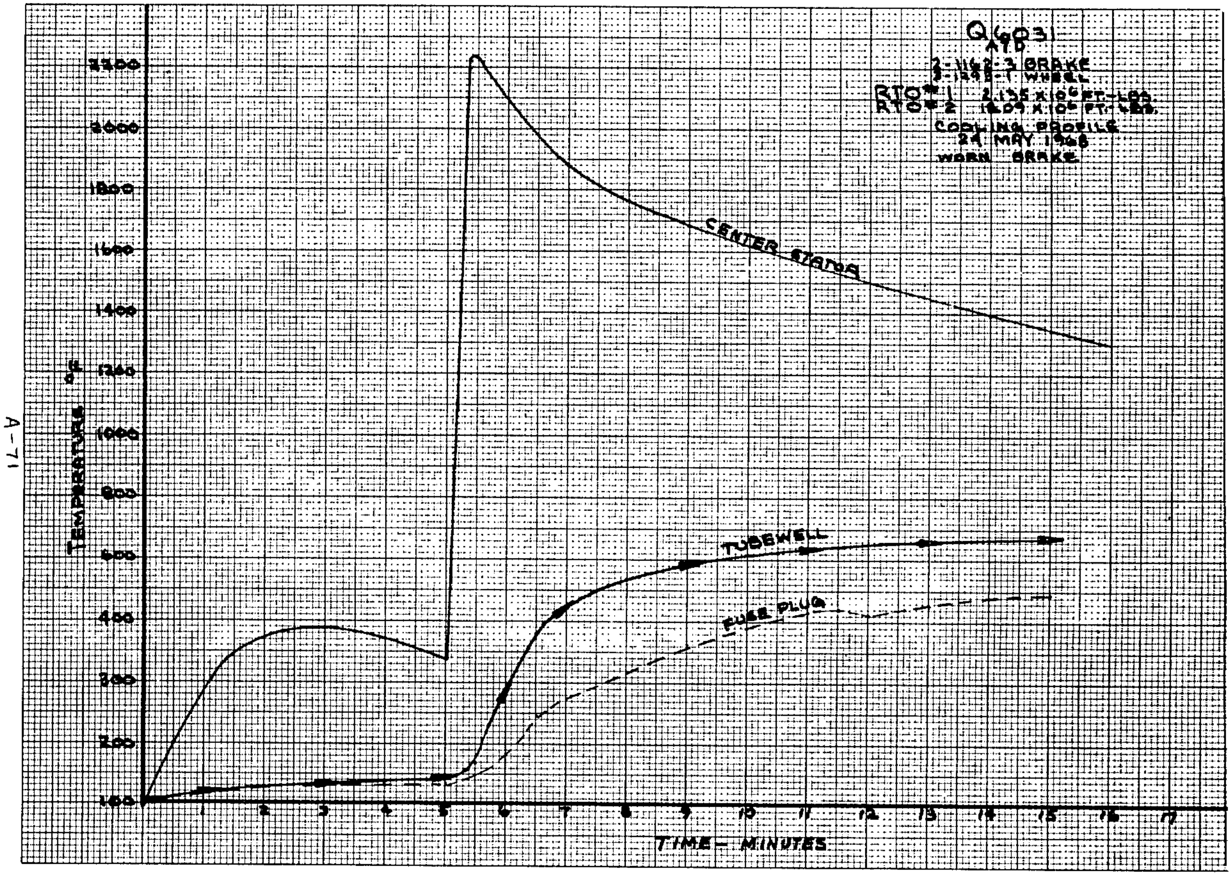
A-69

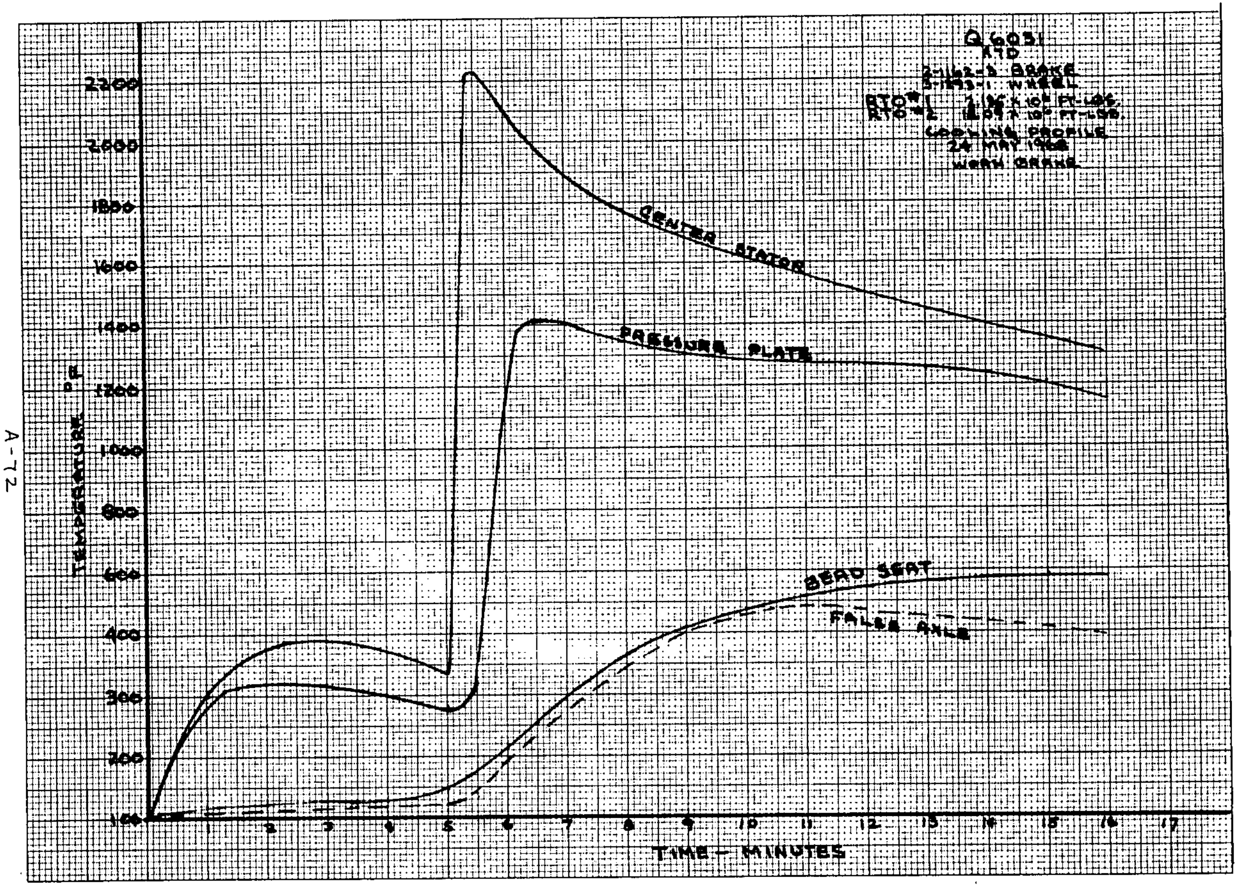


Q 6031
ATD
BRAKE
WHEEL
COOLING PROFILE
WORN BRAKE
#2 Rotor
TORQUE PLATE
PISTON HOUSING
FLUID
TEMPERATURE °F
TIME — MINUTES
2200
2000
1800
1600
1400
1200
1000
800
600
400
300
200
100
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17

A-70

34-919 O - 70 - 9


Q 6031
ATD
BRAKE
WHEEL
RTO #1 2.135 x 10^6 FT-LBS.
RTO #2
COOLING PROFILE
24 MAY 1968
WORN BRAKE
CENTER STATOR
TUBEWELL
FUSE PLUG
TEMPERATURE °F
2200
2000
1800
1600
1400
1200
1000
800
600
400
300
200
100
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
TIME – MINUTES


Q 6031
BRAKE
WHEEL
RTO #1
RTO #2
COOLING PROFILE
24 MAY 1968
WORN BRAKE
CENTER STATOR
PRESSURE PLATE
BEAD SEAT
FALSE AXLE
TEMPERATURE °F
TIME — MINUTES
2200
2000
1800
1600
1400
1200
1000
800
600
400
300
200
100
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17

A-72

B.F.GOODRICH AEROSPACE & DEFENSE PRODUCTS
Wheel and Brake Plant
Troy, Ohio

ENDURANCE TEST — TEST NO. Q-6031 —

Brake Assy No. 2-1162-3 Piston Housing No. 260-439-1 Seals ______ Fluid MIL-H-5606

ENDURANCE TEST

Requirements:
- 25,000 Cycles @ 25 % Worn @ 850 psi @ Amb. °F
- 25,000 Cycles @ 50 % Worn @ 850 psi @ Amb. °F
- 25,000 Cycles @ 75 % Worn @ 850 psi @ Amb. °F
- 25,000 Cycles @ 100 % Worn @ 850 psi @ Amb. °F
- 5,000 Cycles @ 100 % Worn @ 1100 psi @ Amb. °F

Cycle Rate -- cpm
Normal Operating Pressure 850 psi
Maximum Operating Pressure 1100 psi

Date	Time	Brake Cond'n % Worn	Clearance in.	Brake Temp. °F	Brake Press. psi	Cycle Counter	REMARKS
3-16-68	130	25%	.080	80	850	000	Start endurance test
3-17-68	1300	25%	.080	80		14586	
3-18-68	1300	25%	.080	82		27722	Completed 25% wear portion
3-18-68	1500	50%	.080	80		000	Started @ 50% wear
3-19-68	0800	50%	.080	80		10948	
3-20-68	0800	50%	.080	81		26410	Completed 50% wear position
3-20-68	0845	75%	.080	78		000	Start 75% wear condition
3-21-68	1645	75%	.080	80		25160	Completed 75% wear condition
3-22-68	1045	100%	.080	79		0	Start 100% wear condition
3-23-68	1635	100%	.080	80		25504	Completed 100% wear condition

BRAKE RETURN PRESSURE

Requirements:
Back pressure 100 psi
Determine before and after Endurance Test:
Pressure at initial movement.
Pressure at contact.
Pressure at release.

Other ______

Date	Time	PRESSURE Back psi	Init. Move. psi	Contact psi	Release psi	Fully Retr. psi
BEFORE ENDURANCE TEST						
3-16-68	1125	100	40	140	120	25
AFTER ENDURANCE TEST						

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B.F.GOODRICH AEROSPACE & DEFENSE PRODUCTS
Wheel and Brake Plant
Troy, Ohio

ENDURANCE TEST   TEST NO. Q-6031   Sheet 2 of 2

Brake Assy No. 2-1162-3   Piston Housing No. 260-439-1   Seals ____   Fluid MIL-H-5606

ENDURANCE TEST

Requirements:

25,000 Cycles @ 25 % Worn @ 850 psi @ Amb. °F
25,000 Cycles @ 50 % Worn @ 850 psi @ Amb. °F
25,000 Cycles @ 75 % Worn @ 850 psi @ Amb. °F
25,000 Cycles @ 100 % Worn @ 850 psi @ Amb. °F
5,000 Cycles @ 100 % Worn @ 1100 psi @ Amb. °F

Cycle Rate ____ cpm   Normal Operating Pressure 850 psi
Maximum Operating Pressure 1100 psi

Date	Time	Brake Cond'n % Worn	Clearance in.	Brake Temp. °F	Brake Press. psi	Cycle Counter	REMARKS
3-25-68	0800	100%	.080	80	1100	000	Start max. pressure cycling.
3-25-68	1345	100%	.080	81	1100	5020	Completed endurance test Total number of cycles = 109,816. No leakage.

BRAKE RETURN PRESSURE

Requirements:

Back pressure 100 psi

Determine before and after Endurance Test:
Pressure at initial movement.
Pressure at contact.
Pressure at release.

Other ____

Date	Time	PRESSURE Back psi	Init. Move. psi	Contact psi	Release psi	Fully Retr. psi
BEFORE ENDURANCE TEST						
AFTER ENDURANCE TEST						
3-25-68	1410	100	40	140	120	25

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B.F.GOODRICH AEROSPACE & DEFENSE PRODUCTS
Wheel and Brake Plant
Troy, Ohio

EXTREME TEMPERATURE TEST　　TEST NO. Q-6031　　Sheet 1 of 1

Brake Assy No. 2-1162　Condition --　Piston Housing No. 260-439-1　Seals ______　Fluid MIL-H-5606
Other ______

HOT TEST							COLD TEST							
REQUIREMENTS: 168 hrs. @ 850 psi @ 160 °F; 1000 cycles @ 850 psi; 25 cycles @ 1100 psi							REQUIREMENTS: 72 hrs. @ 0 psi @ -65 °F; 25 cycles @ 850 psi; 5 cycles @ 1100 psi							
Date	Time	Oven Temp. °F	Brake Press. psi	Brake Clear. in.	Brake Cycles No.	REMARKS	Date	Time	Cold Box °F	Brake Press. psi	Brake Clear. in.	Brake Cycles No.	Retr. Action Time	REMARKS
11-22-67	1130	70	--	.015		Started heating	11-30-67	1030	Room	--	.015			Started chilling
11-22-67	1430	160	850	.015		Start 168 hr. hot test	11-30-67	1300	-65	--	.015			Started 72 hr. cold test
11-23-67	0800	160	850	.015		Continuing	12-1-67	1300	-65	--	.015			
11-24-67	1200	160	850	.015		Continuing	12-2-67	1300	-65	--	.015			
11-25-67	1200	160	850	.015		Continuing	12-3-67	1300	-65	--	.015	0		No leakage
11-26-67	1430	160	850	.015		Continuing	12-3-67	1303	-65	1100	.015	25	1.0 sec	Brake cycled 25 times @ 1100 psi. There was no leakage. Retraction time between each cycle was 1.0 second.
11-27-67	0800	160	850	.015		Continuing								
11-28-67	0815	160	850	.015		Continuing								
11-29-67	1430	160	850	.015	0	Started 1000 cycles @ 850 psi while at 160°F								
11-29-67	1525	160	1100	.015	1000	Started 25 cycles at 1100 psi								
11-29-67	1530	160	1100	.015	1025	Completed hot test and cycling. No leakage.								

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B.F.GOODRICH AEROSPACE & DEFENSE PRODUCTS
Wheel and Brake Plant
Troy, Ohio

HYDRAULIC PRESSURE TESTS — TEST NO. Q-6031 — Sheet 1 of 1

Brake Assembly No. 2-1162 — Piston Housing No. 260-439-1 — Seals ______ — Fluid MIL-H-5606

LEAKAGE TEST					STATIC TEST					DESTRUCTION				
Requirements: 5 min. @ 1500 psi; 5 min. @ 5 psi; -- Cycles @ -- psi; Normal Operating Press. 850 psi					Requirements: 5 min. @ 2000 psi; Brake condition 100 % worn; Maximum Operating Pressure 1000 psi					Requirements: Determine pressure at destruction.				
Date	Time	Brake Cond'n % Worn	Brake Pressure PSI	Other	Date	Time	Brake Cond'n % Worn	Brake Pressure PSI	Other	Date	Time	Brake Cond'n % Worn	Brake Pressure PSI	Other
12-6-67	1100	25	1500	Held 1500 psi for 5 minutes with no leakage	2-8-68	1000	100	2000	Held 2000 psi for 5 minutes with no leakage	2-8-68	1005	1000	3170	Failure @ 3170 psi
12-6-67	1105	25	5	Held 5 psi for 5 min. with no leakage										

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B.F.GOODRICH AEROSPACE & DEFENSE PRODUCTS
Wheel and Brake Plant
Troy, Ohio

HYDRAULIC TEST LOG   TEST NO. Q-6031   Sheet 1 of 1

Type Of Test Salt Fog   Part No. 2-1162-3   Fluid --   Station Salt Chamber

Date	Time	Temp. °F	Press. PSI	Counter Reading				REMARKS
5-21-68	1030							Begin Salt Fog Test
5-22-68	1030							Test check
5-23-68	1030							Removed brake from salt chamber
5-23-68	1500							Pumped brake to 1500 psi. Then released. Brake functioning normally.

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B.F.GOODRICH AEROSPACE & DEFENSE PRODUCTS
Wheel and Brake Plant
Troy, Ohio

TEST NO. Q-6031

STRUCTURAL TORQUE TEST

Date 4-25-68

TEST CONFIGURATION

BRAKE ASSEMBLY NO. 2-1162-3

Size 12 x 4 wt 108 lbs
Disk No. 134-44 Material Steel
Lining No. 244-270 Material 5043A
Piston Housing No. ____ Material Aluminum

WHEEL ASSEMBLY NO. 3-1293-1

Size 28 x 9.0-14 wt 45 lbs
Inner Half No. 10-1181 Chg. A Material Aluminum
Heat No. -- Fin. Wt. -- lbs Mark L342

Outer Half No. 10-1180 Chg. A Material Aluminum
Heat No. -- Fin. Wt. -- lbs Mark L342

TIRE

Make BFG Size & Type 28 x 9.0-14 Type VIII
Tubeless X Ply 22 Inf. (psi) 270 S/N N/A

Prior test on same assemblies: None

TEST EQUIPMENT

Dynamometer: 120 inch left arm

REQUIREMENTS and RESULTS

REQUIREMENTS

Specification MIL-W-5013G

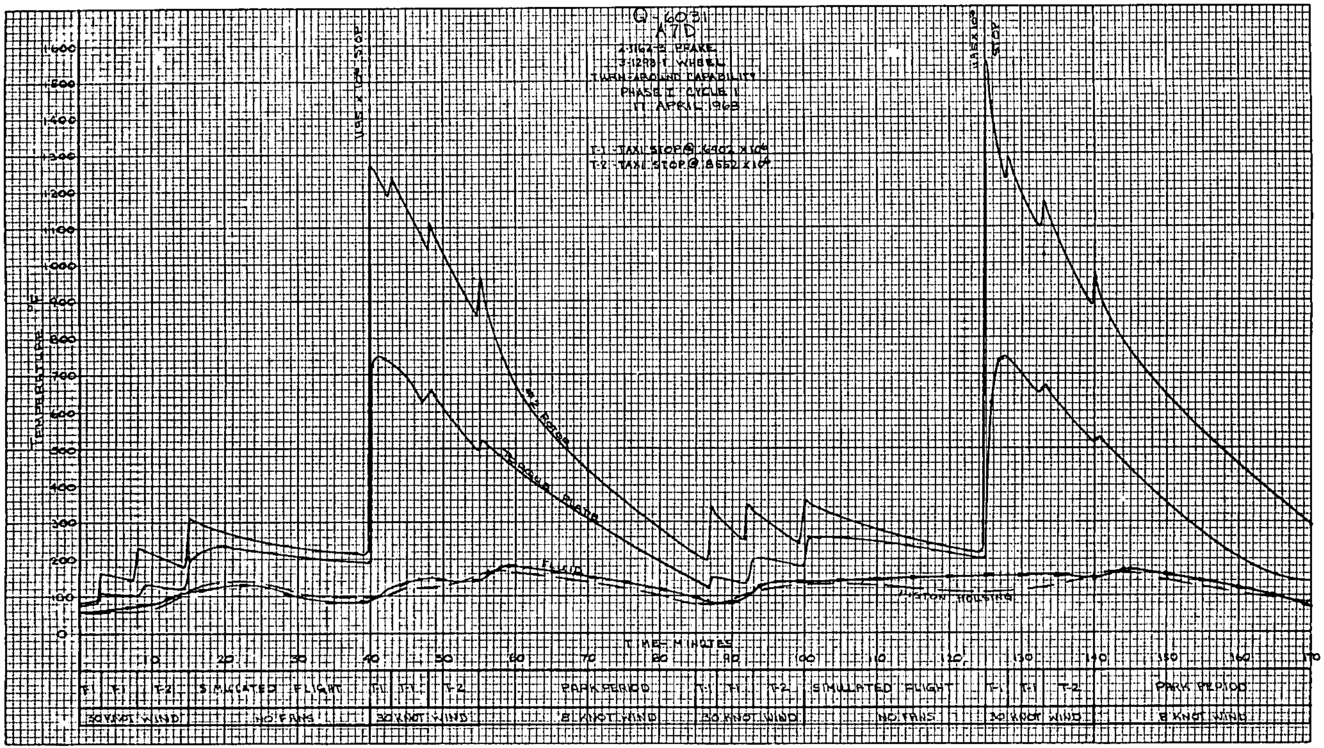
Structural Torque 20850 lb ft Rolling Radius 11.9 ins
Tangential Load -- lbs Brake Pressure 1000 psi
Tiebolt Torque 1440 lb in
Mounting Conditions:
Straight Axle ____ Offset 8 in
Friction Stack:
Pinned ____ Bolted ____ Welded X Other ____

RESULTS

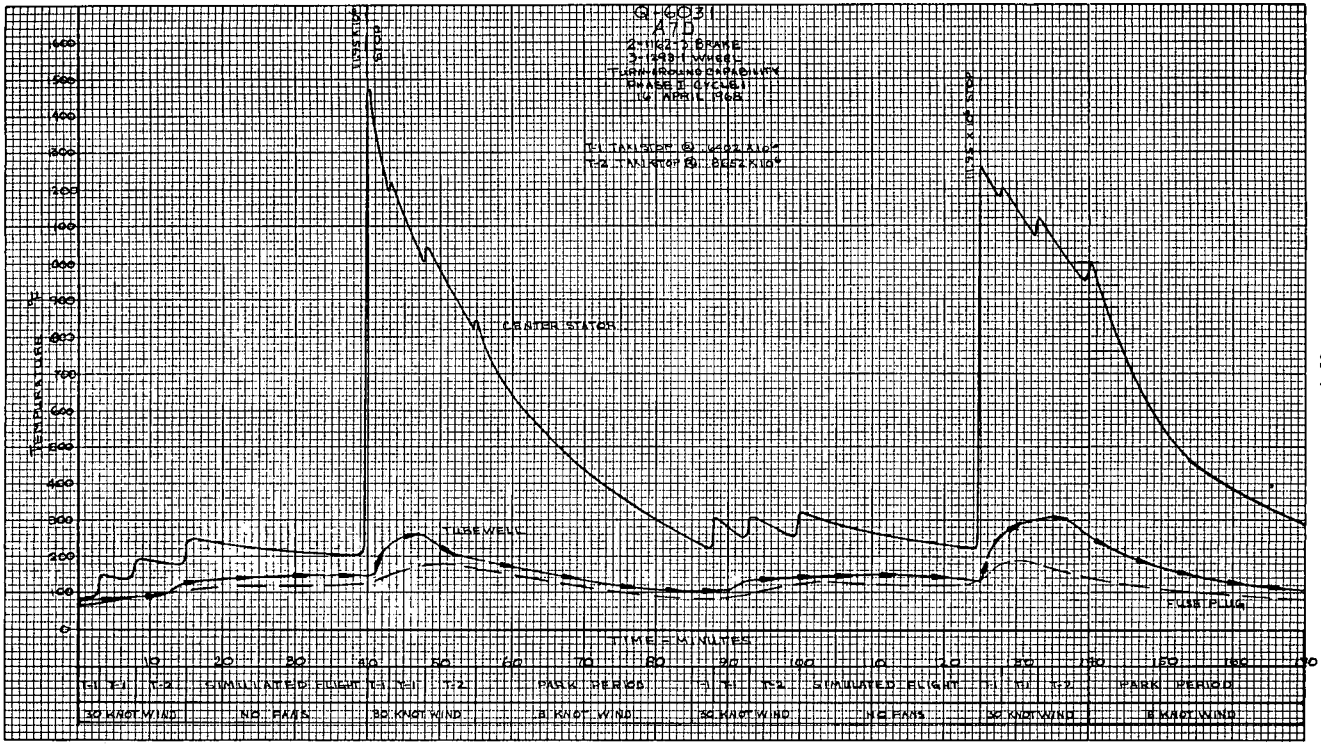
Torque 21880 lb ft (Oscillograph)
Torque 21940 lb ft (Panel Recorder)
Offset Factor -- Actual Torque 21940 lb ft
Rolling Radius 11.9 ins
Brake Pressure 1000 psi (Oscillograph)
Brake Pressure ____ psi (Panel Recorder)

REMARKS

A-78

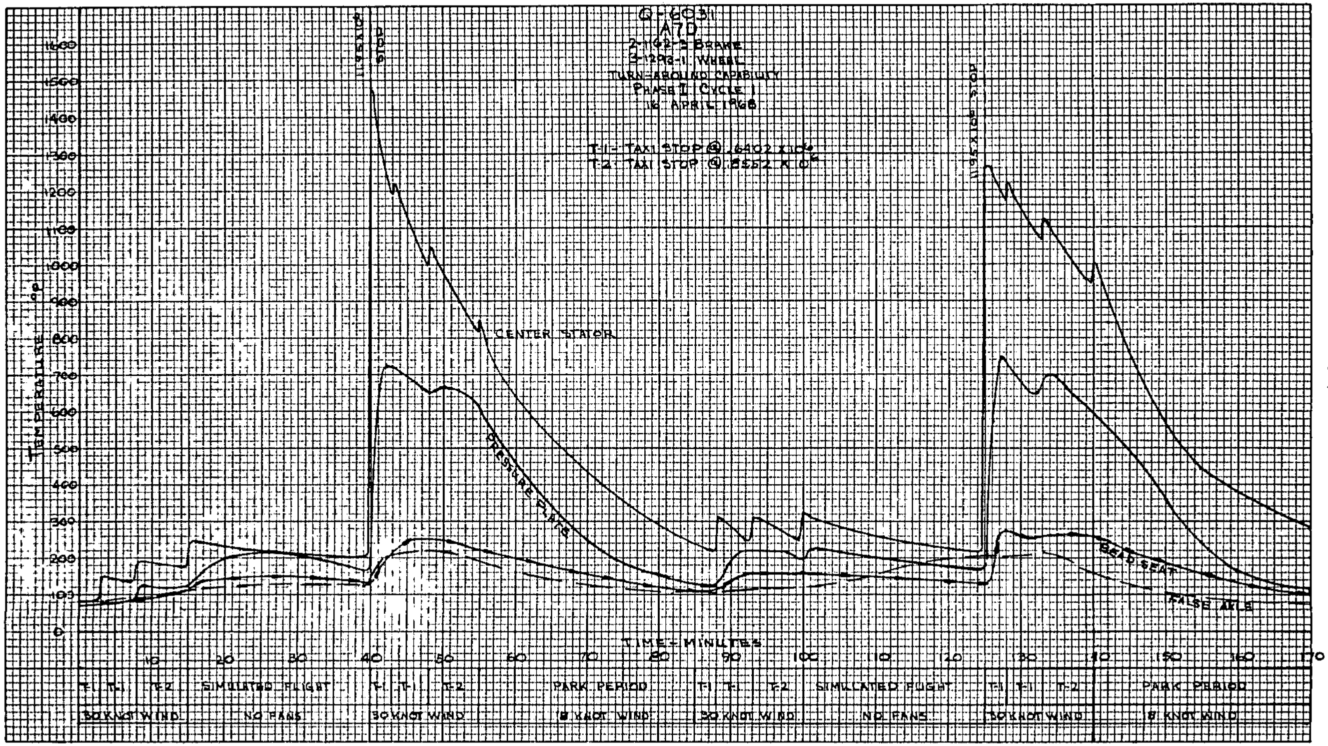


Q-6031
A7D
2-1162-2 BRAKE
3-1293 T WHEEL
TURNAROUND CAPABILITY
PHASE I CYCLE 1
17 APRIL 1968
T-1 TAXI STOP @ .6402 X10^6
T-2 TAXI STOP @ .8662 X10^6
TEMPERATURE °F
TIME-MINUTES
FLUID
PISTON HOUSING
PRESSURE PLATE
STOP
T-1
T-2
SIMULATED FLIGHT
PARK PERIOD
30 KNOT WIND
NO FANS
8 KNOT WIND

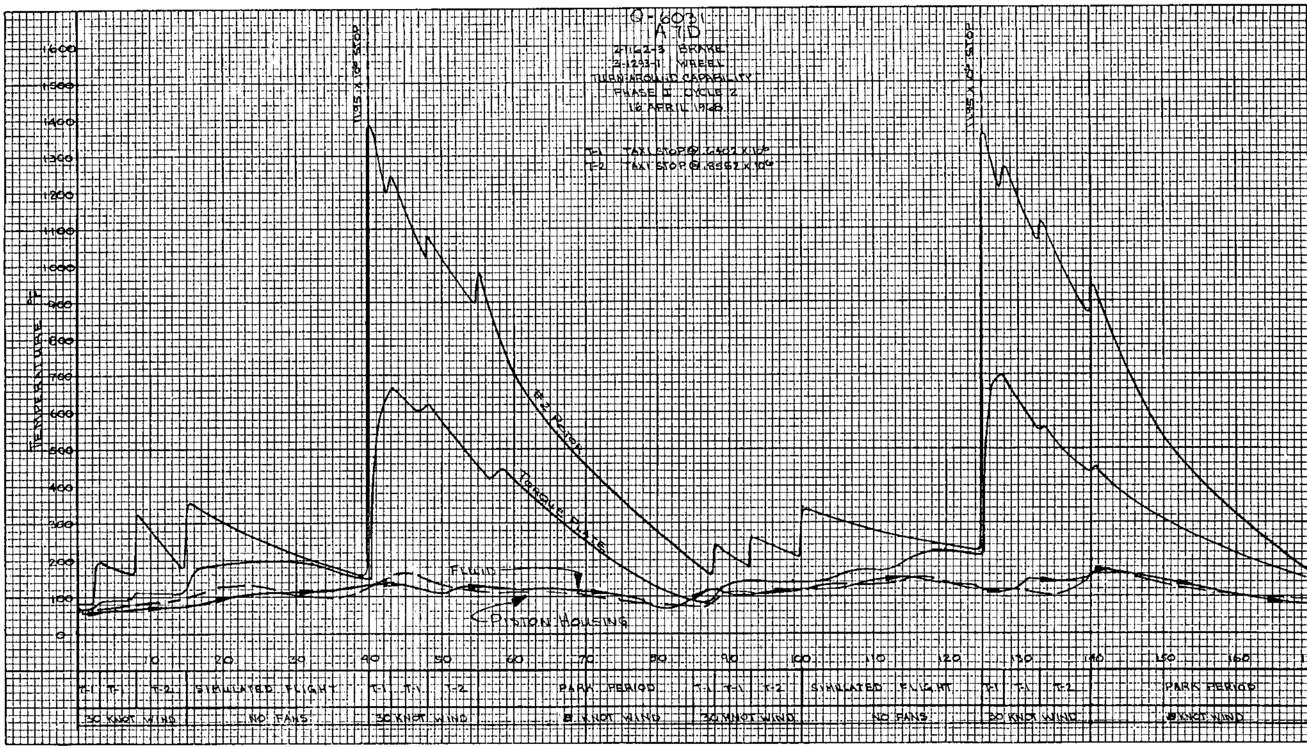


Q-6031
A7D
TURNAROUND CAPABILITY
14 APRIL 1968
CENTER STATOR
TUBEWELL
FUSE PLUG
TEMPERATURE °F
TIME – MINUTES
SIMULATED FLIGHT
PARK PERIOD
30 KNOT WIND
NO FANS
8 KNOT WIND

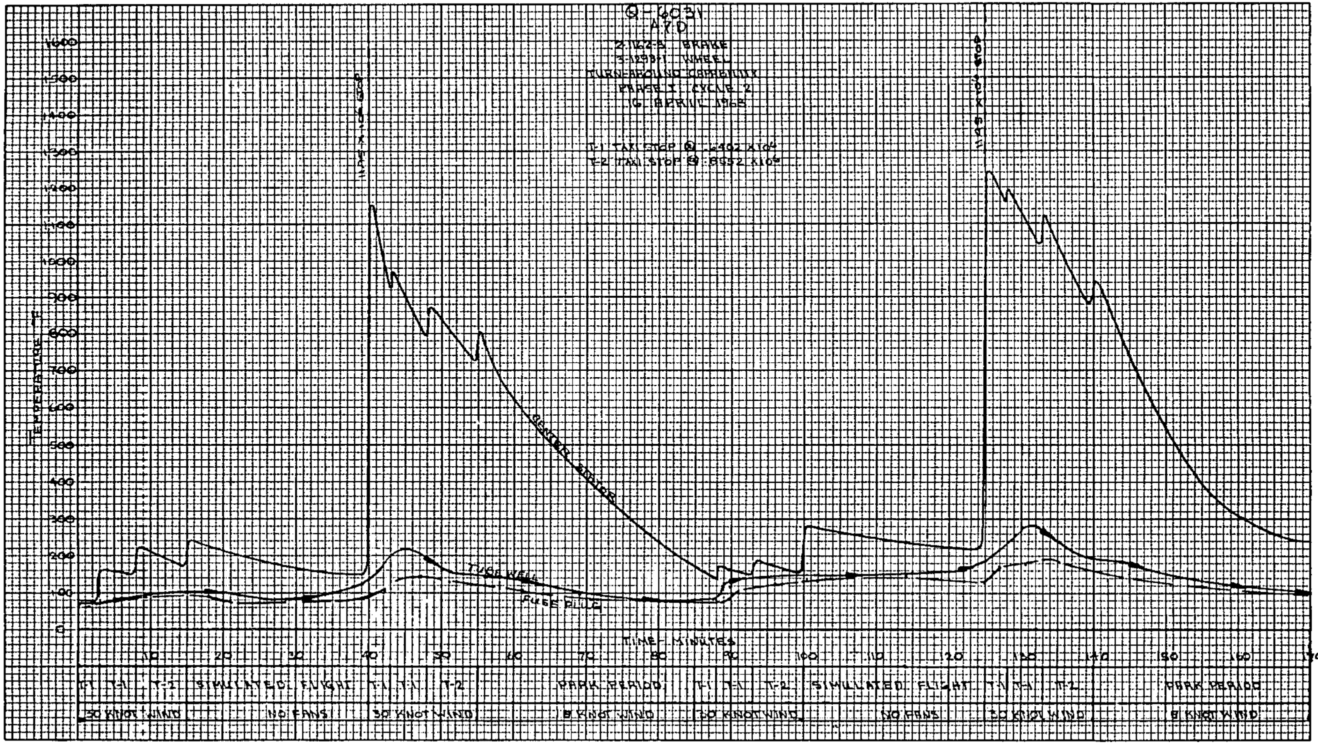
135

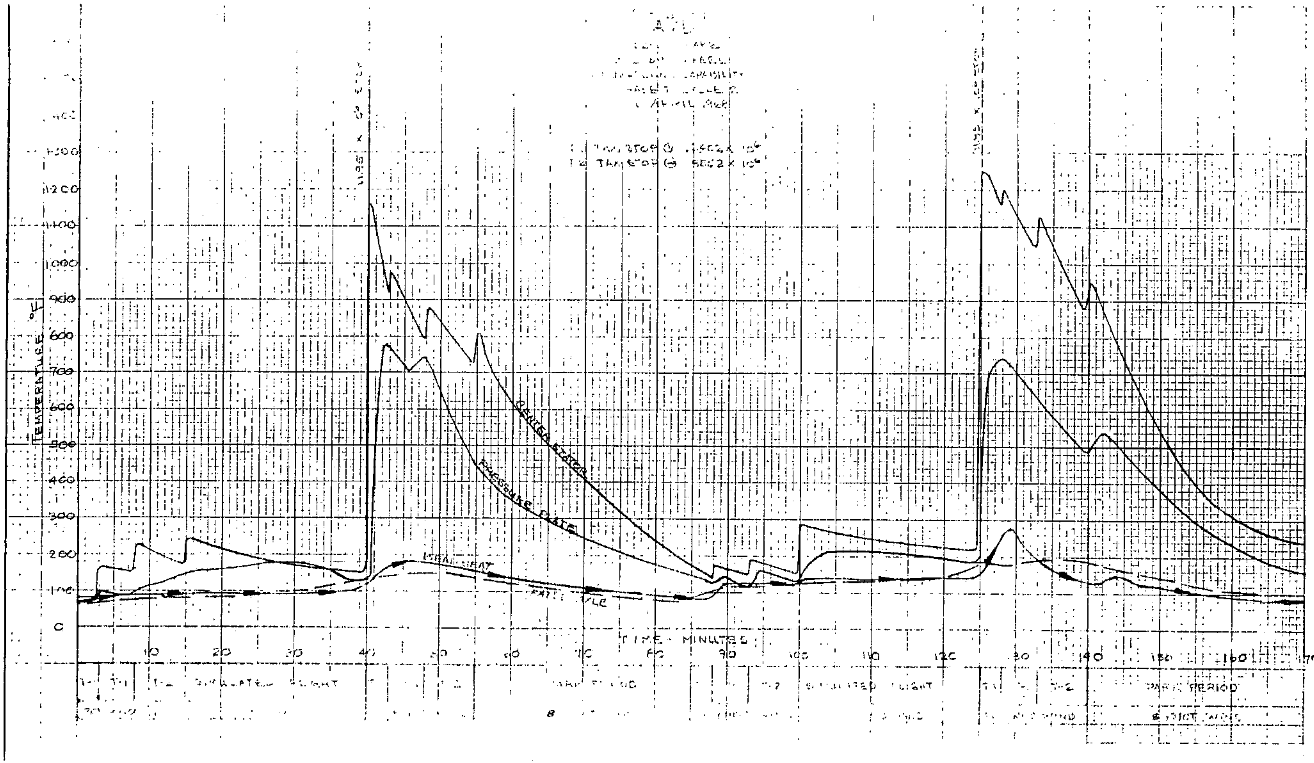


Q-6C31
A7D
2-1162-3 BRAKE
3-1293-1 WHEEL
TURN-AROUND CAPABILITY
PHASE I CYCLE 1
16 APRIL 1968
T-1 - TAXI STOP @ .6402 X 10^6
T-2 - TAXI STOP @ .5552 X 10^6
1.195 X 10^6 STOP
CENTER STATOR
PRESSURE PLATE
BEAD SEAT
FALSE AXLE
TEMPERATURE °F
TIME - MINUTES
T-1 T-1 T-2 SIMULATED FLIGHT T-1 T-1 T-2 PARK PERIOD T-1 T-1 T-2 SIMULATED FLIGHT T-1 T-1 T-2 PARK PERIOD
30 KNOT WIND NO FANS 30 KNOT WIND 8 KNOT WIND 30 KNOT WIND NO FANS 30 KNOT WIND 8 KNOT WIND

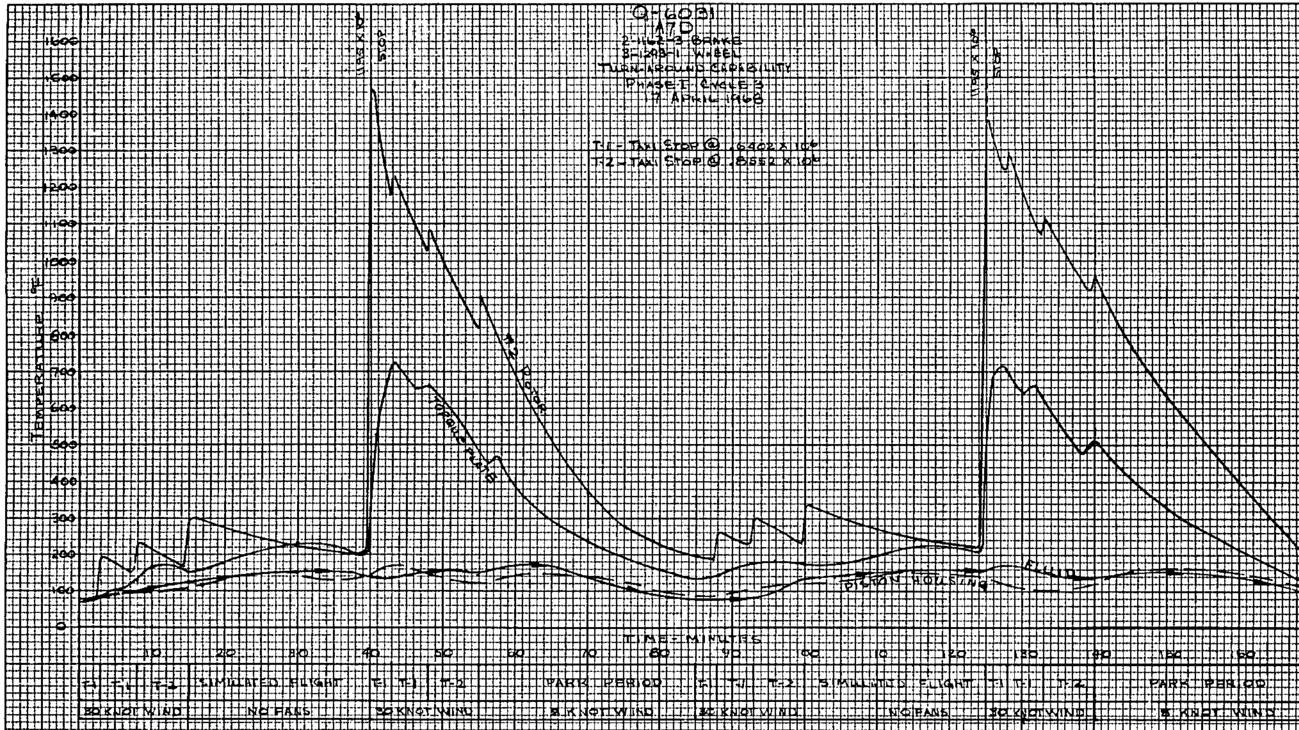


Q-6031
A7D
2-1162-3 BRAKE
3-1293-1 WHEEL
TURNAROUND CAPABILITY
PHASE II CYCLE 2
16 APRIL 1968
T-1 TAXI STOP @ .6402 X 10^6
T-2 TAXI STOP @ .8552 X 10^6
1.35 X 10^6 STOP
TEMPERATURE °F
#2 ROTOR
TORQUE PLATE
FLUID
PISTON HOUSING
T-1 T-1 T-2 SIMULATED FLIGHT T-1 T-1 T-2 PARK PERIOD T-1 T-1 T-2 SIMULATED FLIGHT T-1 T-1 T-2 PARK PERIOD
30 KNOT WIND NO FANS 30 KNOT WIND 8 KNOT WIND 30 KNOT WIND NO FANS 30 KNOT WIND 8 KNOT WIND

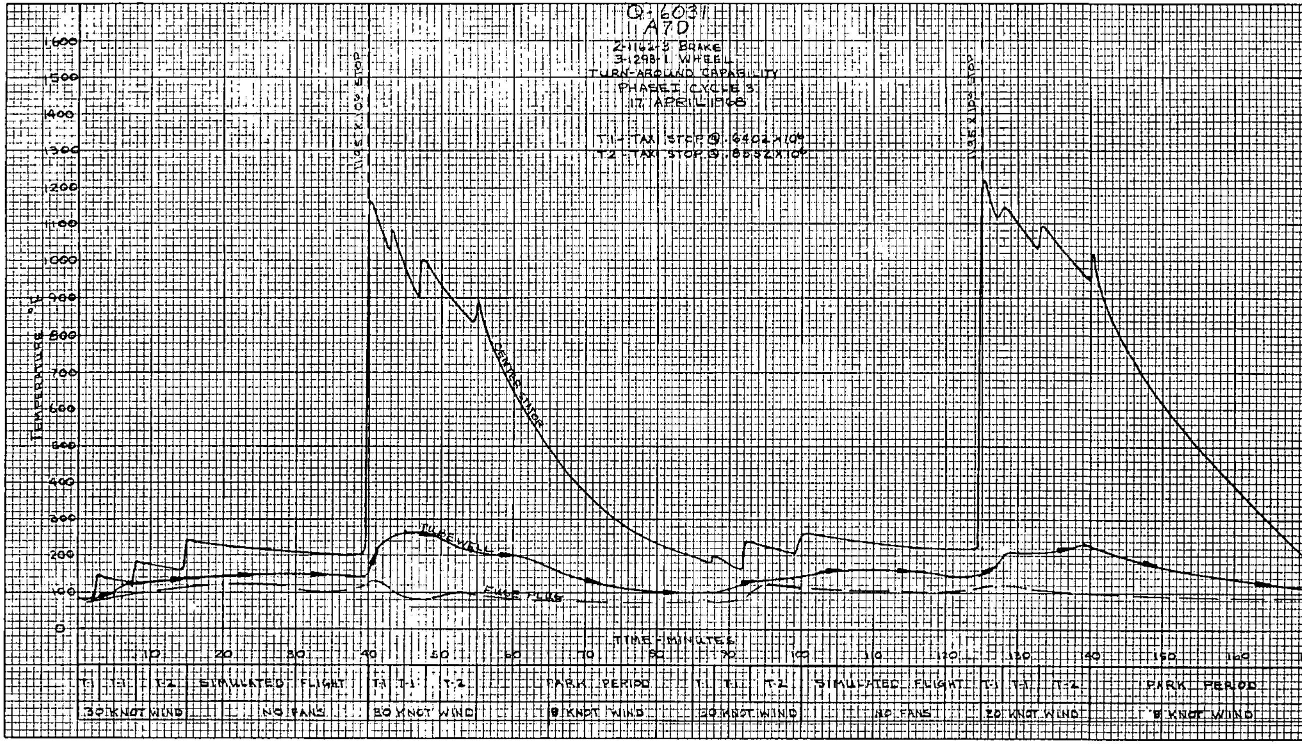

Q-6031
A7D
2-1162-3 BRAKE
3-1299-1 WHEEL
TURN-AROUND CAPABILITY
PHASE I CYCLE 2
6 APRIL 1968
T-1 TAXI STOP @ .6402 X10⁶
T-2 TAXI STOP @ .8552 X10⁶
TEMPERATURE °F
TIME - MINUTES
CENTER ROTOR
TIRE WELL
FUSE PLUG
SIMULATED FLIGHT
PARK PERIOD
30 KNOT WIND
NO FANS
8 KNOT WIND


TEMPERATURE °F
CENTER STATOR
PRESSURE PLATE
TIME - MINUTES
0
100
200
300
400
500
600
700
800
900
1000
1100
1200
1300
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
160
170
SIMULATED FLIGHT
PARK PERIOD

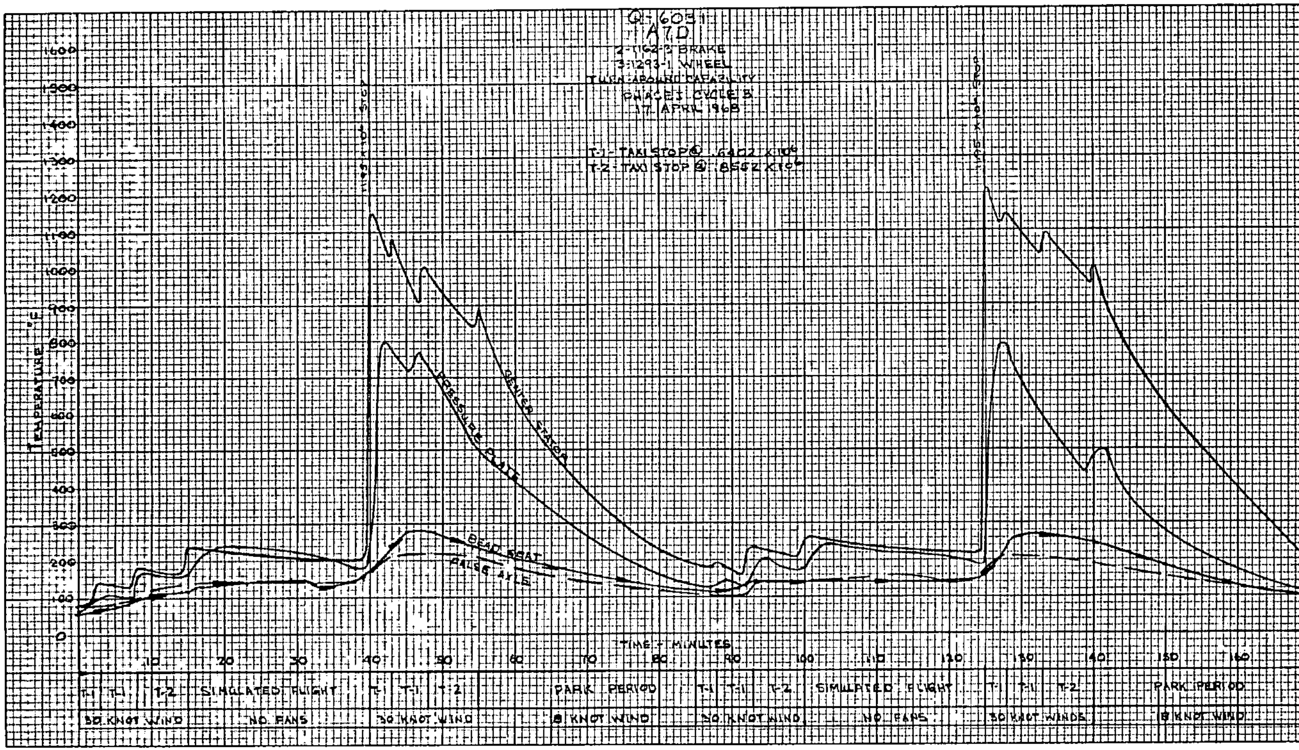
A-84



Q-6031
A7D
2-1162-3 BRAKE
3-1293-1 WHEEL
TURN-AROUND CAPABILITY
PHASE I CYCLE 3
17 APRIL 1968
T-1 - TAXI STOP @ .6402 X 10⁶
T-2 - TAXI STOP @ .8552 X 10⁶
STOP
#2 ROTOR
TORQUE PLATE
FLUID
PISTON HOUSING
TEMPERATURE °F
TIME - MINUTES
T-1 T-1 T-2 SIMULATED FLIGHT T-1 T-1 T-2 PARK PERIOD T-1 T-1 T-2 SIMULATED FLIGHT T-1 T-1 T-2 PARK PERIOD
30 KNOT WIND NO FANS 30 KNOT WIND 5 KNOT WIND 30 KNOT WIND NO FANS 30 KNOT WIND 5 KNOT WIND

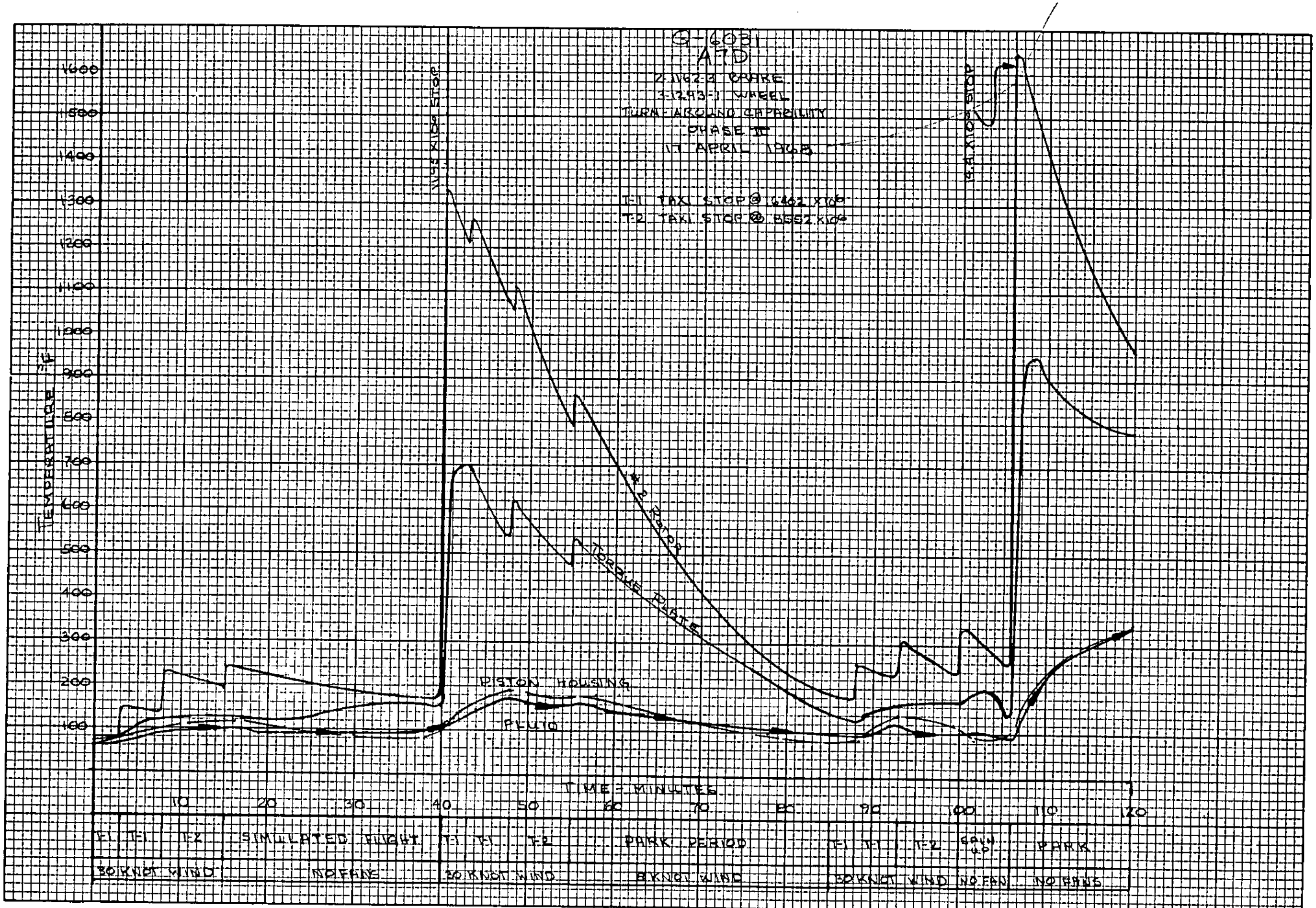


Q-6031
A7D
2-1162-3 BRAKE
3-1298-1 WHEEL
TURN-AROUND CAPABILITY
PHASE I CYCLE 3
17 APRIL 1968
T1 - TAX STOP @ .6402 x 10⁶
T2 - TAX STOP @ .8552 x 10⁶
TEMPERATURE °F
CENTER STATOR
TUBE WELL
FUSE PLUG
TIME - MINUTES
T-1
T-2
SIMULATED FLIGHT
PARK PERIOD
30 KNOT WIND
NO FANS
20 KNOT WIND
8 KNOT WIND

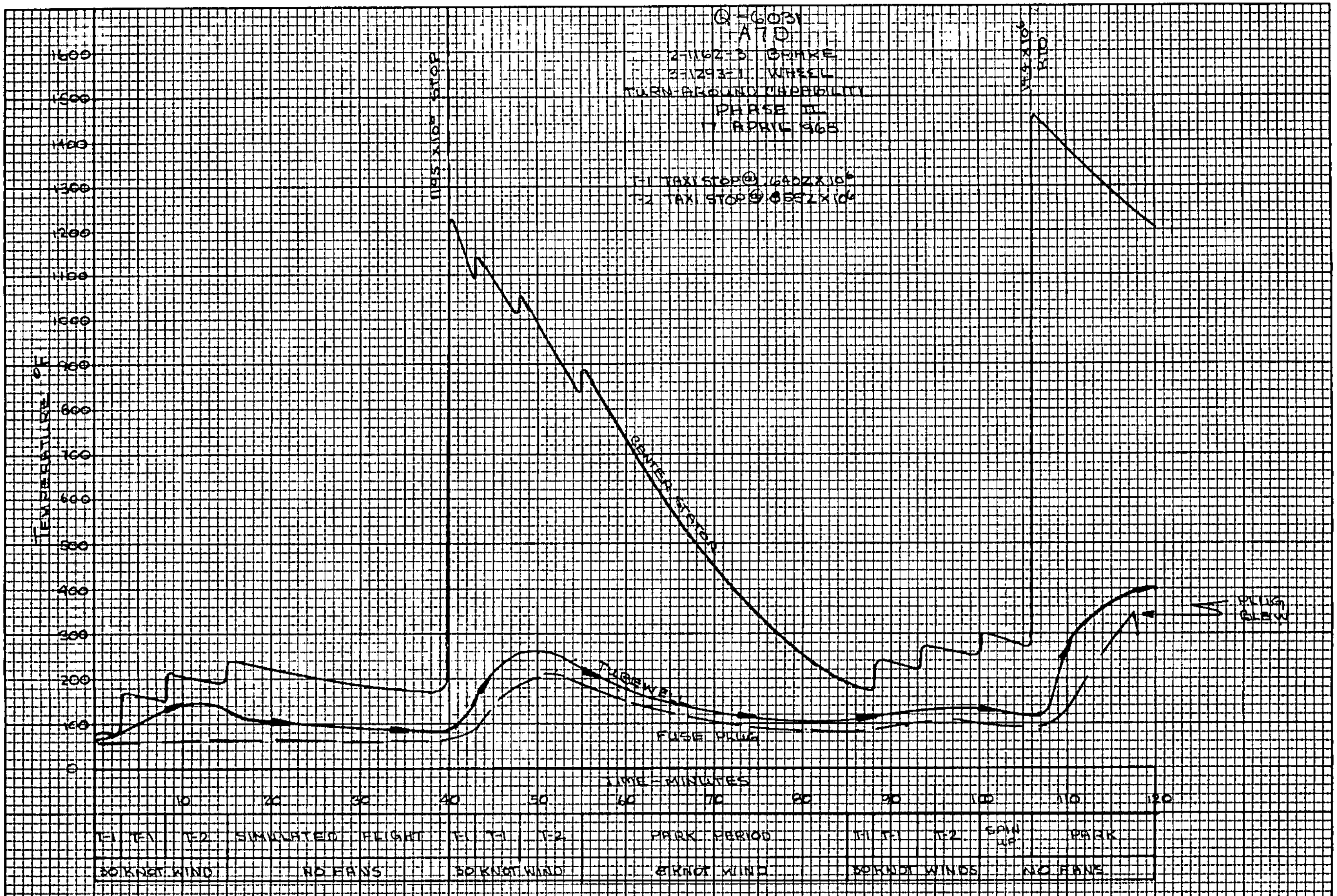


A-87

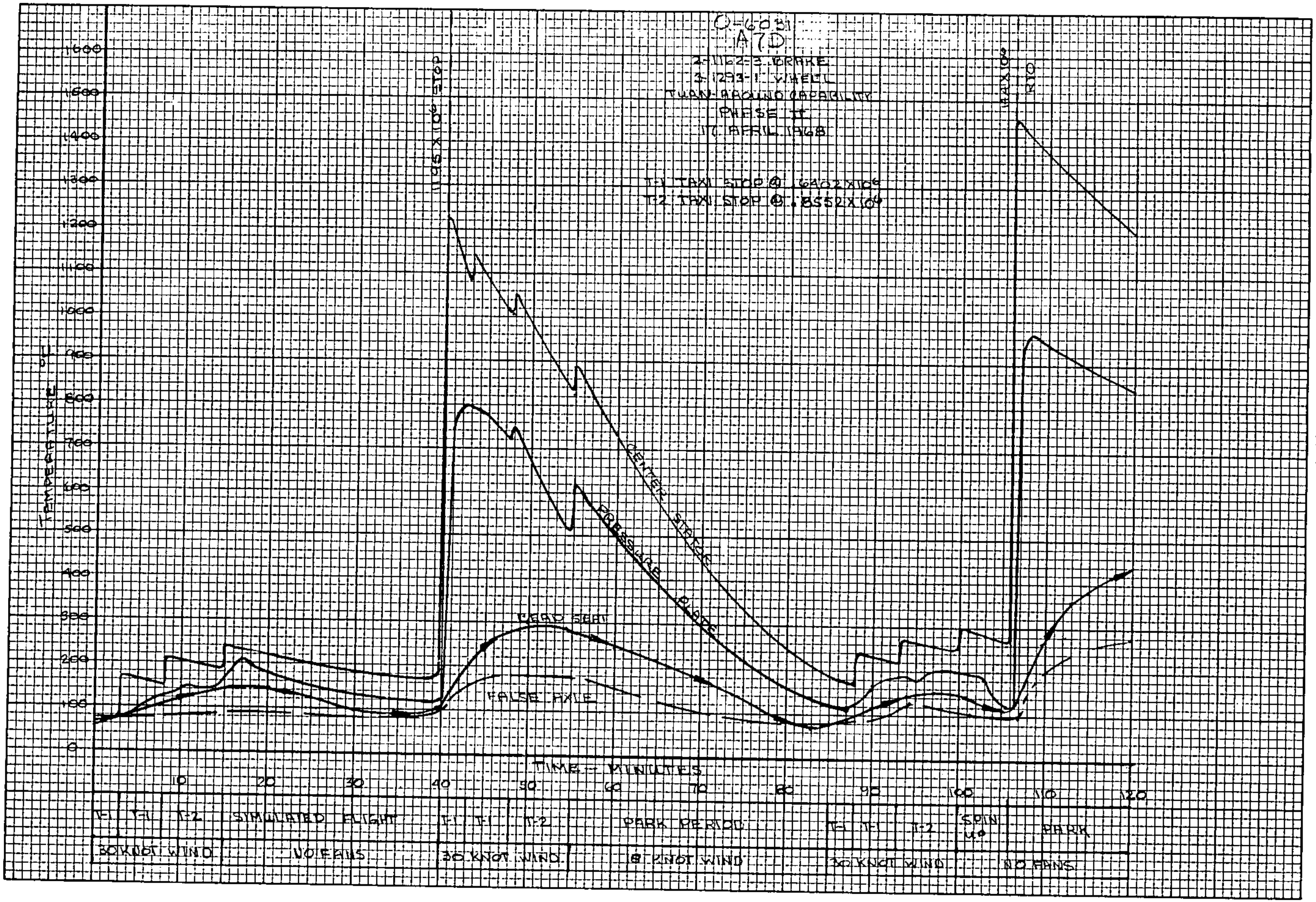
34-919 O - 70 - 10



G-6081
ATD
2-1162-3 BRAKE
3-1293-1 WHEEL
TURN-AROUND CAPABILITY
PHASE II
17 APRIL 1968
T-1 TAXI STOP @ 6462 X10⁶
T-2 TAXI STOP @ 8552 X10⁶
TEMPERATURE °F
1600
1500
1400
1300
1200
1100
1000
900
800
700
600
500
400
300
200
100
ROTOR
TORQUE PLATE
PISTON HOUSING
FLUID
TIME - MINUTES
10
20
30
40
50
60
70
80
90
100
110
120
T-1
T-2
SIMULATED FLIGHT
PARK PERIOD
PARK
30 KNOT WIND
NO FANS
8 KNOT WIND
NO FAN



Q-6031
A7D
2-1162-3 BRAKE
3-1293-1 WHEEL
TURN-AROUND CAPABILITY
PHASE III
17 APRIL 1968
TEMPERATURE - °F
TIME - MINUTES
CENTER STATOR
TUBEWELL
FUSE PLUG
PLUG BLEW
SIMULATED FLIGHT
PARK PERIOD
PARK
SPIN UP
30 KNOT WIND
NO FANS
8 KNOT WIND
30 KNOT WINDS


O-6081
A7D
2-1162-3 BRAKE
3-1293-1 WHEEL
TURN-AROUND CAPABILITY
PHASE II
17 APRIL 1968
T-1 TAXI STOP @ .6402X10⁶
T-2 TAXI STOP @ .8552X10⁶
1.195 X 10⁶ STOP
RTO
TEMPERATURE °F
1600
1500
1400
1300
1200
1100
1000
900
800
700
600
500
400
300
200
100
0
CENTER STATOR
PRESSURE PLATE
CERO SEAT
FALSE AXLE
TIME - MINUTES
10
20
30
40
50
60
70
80
90
100
110
120
T-1
T-1
T-2
SIMULATED FLIGHT
T-1
T-1
T-2
PARK PERIOD
T-1
T-1
T-2
SPIN UP
PARK
30 KNOT WIND
NO FANS
30 KNOT WIND
8 KNOT WIND
30 KNOT WIND
NO FANS

B.F.GOODRICH AEROSPACE & DEFENSE PRODUCTS
Wheel and Brake Plant
Troy, Ohio

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BRAKE TEST LOG

TEST NO. Q-6031

Sheet 1 of 7
Date 4-16-68

REQUIREMENTS:

LANDING VELOCITY As noted mph
STOP TIME As noted sec
STOP DISTANCE -- ft

PRESSURE: 140 psi back
-- psi min.
-- psi max.

OTHER Turn-Around Capability

Stop No.	Log Time	Landing Velocity mph	Brake Press. psi	Stop Time sec	Stop Distance ft	TORQUE Avg. lb ft	TORQUE Peak lb ft	TEMPERATURES °F * Center Stator Initial	Center Stator Peak	Piston Housing Initial	Piston Housing Peak	Torque Plate Initial	Torque Plate Peak	* OTHER PEAK TEMPERATURES °F 4	5	6	7	8	9	10	
							Phase I Cycle 1														
T1	1327	35		Begin test - 3 minutes taxi																	
1	1330	35	550	4.5		6720	7800														
T1		35		5 minute taxi																	
2	1335	35	500	4.9		6720	7800														
T2		40.5		7 minute taxi																	
3	1342	40.5	500	6.0		6360	7680														
SF		Simulated flight period - No Fans																			
4	1407	151	700	24.6		5520	7320														
T1		35		3 minute taxi																	
5	1410	35	480	7.0		5040	6480														
T1		35		5 minute taxi																	
6	1415	35	500	5.9		5400	6840														
T2		40.5		7 minute taxi																	
7	1422	40.5	500	7.0		5280	6720														
PP				30 minute park period																	
T1	1452	35		3 minute taxi																	
8	1455	35	500	5.5		5750	7850														
T1				5 minute taxi																	
9	1500	35	500	5.5		5760	8540														
T2		40.5		7 minute taxi																	

REMARKS *See temperature curves

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B.F.GOODRICH AEROSPACE & DEFENSE PRODUCTS
Wheel and Brake Plant
Troy, Ohio

BRAKE TEST LOG TEST NO. Q-6031 Sheet 2 of 7

Date 4-16-68

REQUIREMENTS:

LANDING VELOCITY As noted mph PRESSURE: 140 psi back OTHER Turn-Around Capability

STOP TIME As noted sec -- psi min.

STOP DISTANCE -- ft -- psi max.

Stop No.	Log Time	Landing Velocity mph	Brake Press. psi	Stop Time sec	Stop Distance ft	TORQUE Avg. lb ft	TORQUE Peak lb ft	* TEMPERATURES °F Center Stator Initial	Center Stator Peak	Piston Housing Initial	Piston Housing Peak	Torque Plate Initial	Torque Plate Peak	* OTHER PEAK TEMPERATURES °F 4	5	6	7	8	9	10	
10	1507	40.5	500	6.5		5640	8100														
SF					Simulated flight period - No Fans																
11	1532	151	700	22.8		5040	5950														
T1		35			3 minute taxi																
12	1535	35	500	6.8		5040	5950														
T1		35			5 minute taxi																
13	1540	35	500	6.7		4920	6000														
T2		40.5			7 minute taxi																
14	1547	40.5	500	7.1		5100	6060														
PP					30 minute park period																
	1617	End Phase 1 Cycle 1																			
						Phase 1 Cycle 2															
T1	2045	35			Begin Cycle 2 - 3 minute taxi																
15	2048	35	500	5.9		5760	7320														
T1		35			5 minute taxi																
16	2053	35	500	5.9		5760	7320														
T2		40.5			7 minute taxi																
17	2100	40.5	500	7.2		5520	7140														
SF					Simulated flight - No Fans																
18	2125	151	700	23.8		6000	7800														
T1		35			3 minute taxi																

REMARKS * See temperature curves

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B.F.GOODRICH AEROSPACE & DEFENSE PRODUCTS
Wheel and Brake Plant
Troy, Ohio

BRAKE TEST LOG

TEST NO. Q-6031

Sheet 3 of 7
Date 4-16-68

REQUIREMENTS:

LANDING VELOCITY As noted mph
STOP TIME As noted sec
STOP DISTANCE -- ft

PRESSURE: 140 psi back
-- psi min.
-- psi max.

OTHER Turn-Around Capability

Stop No.	Log Time	Landing Velocity mph	Brake Press. psi	Stop Time sec	Stop Distance ft	TORQUE Avg. lb ft	TORQUE Peak lb ft	* TEMPERATURES °F Center Stator Initial	Center Stator Peak	Piston Housing Initial	Piston Housing Peak	Torque Plate Initial	Torque Plate Peak	* OTHER PEAK TEMPERATURES °F 4	5	6	7	8	9	10
19	2128	35	500	7.0		4550	5780													
T1		35			5 minute taxi															
20	2133	35	510	7.3		4680	5780													
T2		40.5			7 minute taxi															
21	2140	40.5	540	8.0		4800	6470													
PP					Park period															
T1	2210	35			3 minute taxi															
22	2213	35	540	6.4		5760	7920													
T1		35			5 minute taxi															
23	2218	35	555	6.0		5460	7800													
T2		40.5			7 minute taxi															
24	2225	40.5	570	7.0		5800	7800													
SF					Simulated flight															
25	2250	151	800	20.7		6480	9000													
T1		35			3 minute taxi															
26	2253	35	565	7.0		4800	5950													
T1		35			5 minute taxi															
27	2258	35	565	6.9		5040	6250													
T2		40.5			7 minute taxi															
28	2305	40.5	580	7.9		4800	6420													
PP					30 minute park period															
		End Phase 1 Cycle 2																		

REMARKS * See temperature curves

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B.F.GOODRICH AEROSPACE & DEFENSE PRODUCTS
Wheel and Brake Plant
Troy, Ohio

BRAKE TEST LOG

TEST NO. Q-6031

Sheet 4 of 7
Date 4-17-68

REQUIREMENTS:

LANDING VELOCITY As noted mph
STOP TIME As noted sec
STOP DISTANCE -- ft

PRESSURE: 140 psi back
psi min.
psi max.

OTHER Turn-Around Capability

A-94

Stop No.	Log Time	Landing Velocity mph	Brake Press. psi	Stop Time sec	Stop Distance ft	TORQUE		* TEMPERATURES °F						* OTHER PEAK TEMPERATURES °F							
						Avg. lb ft	Peak lb ft	Center Stator		Piston Housing		Torque Plate									
								Initial	Peak	Initial	Peak	Initial	Peak	4	5	6	7	8	9	10	
						Phase 1 Cycle 3															
T1	0245	Begin Cycle 3 - 3 minute taxi																			
29	0248		560	6.7		5100	7320														
T1					5 minute taxi																
30	0253		500	6.0		5750	8520														
T2					7 minute taxi																
31	0300		600	7.0		4980	7680														
SF					Simulated flight - No Fans																
32	0325		760	22.1		6000	8880														
T1					3 minute taxi																
33	0328		620	6.4		5280	6240														
T1					5 minute taxi																
34	0333		640	6.0		5280	6600														
T2					7 minute taxi																
35	0340		640	7.4		4800	6720														
PP					30 minute park period																
T1	0410				3 minute taxi																
36	0413		680	5.8		5520	8580														
T1					5 minute taxi																
37	0418		680	5.9		5400	8340														
T2					7 minute taxi																

REMARKS * See temperature curves

EP355

B.F.GOODRICH AEROSPACE & DEFENSE PRODUCTS
Wheel and Brake Plant
Troy, Ohio

BRAKE TEST LOG

TEST NO. Q-6031

Sheet 5 of 7
Date 4-17-68

REQUIREMENTS:

LANDING VELOCITY As noted mph
STOP TIME As noted sec
STOP DISTANCE -- ft

PRESSURE: 140 psi back
-- psi min.
-- psi max.

OTHER Turn-Around Capability

A-95

Stop No.	Log Time	Landing Velocity mph	Brake Press. psi	Stop Time sec	Stop Distance ft	TORQUE Avg. lb ft	TORQUE Peak lb ft	* TEMPERATURES °F Center Stator Initial	Center Stator Peak	Piston Housing Initial	Piston Housing Peak	Torque Plate Initial	Torque Plate Peak	* OTHER PEAK TEMPERATURES °F 4	5	6	7	8	9	10	
38	0425		680	7.1		5220	8340														
SF					Simulated flight period - No Fans																
39	0450		800	21.7		6480	9000														
T1					3 minutes taxi																
40	0453		700	6.0		5640	7200														
T1					5 minute taxi																
41	0458		700	5.8		5400	7320														
T2					7 minute taxi																
42	0505		700	7.0		6200	7500														
PP																					

REMARKS * See temperature curves

EP355

B.F.GOODRICH AEROSPACE & DEFENSE PRODUCTS
Wheel and Brake Plant
Troy, Ohio

BRAKE TEST LOG

TEST NO. Q-6031

Sheet 6 of 7
Date 4-17-68

REQUIREMENTS:

LANDING VELOCITY As noted mph
STOP TIME As noted sec
STOP DISTANCE -- ft

PRESSURE: 140 psi back
-- psi min.
-- psi max.

OTHER Turn-Around Capability

Stop No.	Log Time	Landing Velocity mph	Brake Press. psi	Stop Time sec	Stop Distance ft	TORQUE Avg. lb ft	TORQUE Peak lb ft	* TEMPERATURES °F Center Stator Initial	Center Stator Peak	Piston Housing Initial	Piston Housing Peak	Torque Plate Initial	Torque Plate Peak	* OTHER PEAK TEMPERATURES °F 4	5	6	7	8	9	10	
						Phase 2 Cycle 1															
		Begin Phase 2 Cycle 1																			
T1	1327	32.3			3 minute taxi																
1	1330	32.3	500	6.6		4800	7020														
T1		32.3			5 minute taxi																
2	1335	32.3	500	6.7		4800	7080														
T2		37.5			7 minute taxi																
3	1342	37.5	500	8.1		4740	6900														
SF					Simulated flight - No Fans																
4	1407	139.5	700	24.6		6000	7440														
T1		32.3			3 minute taxi																
5	1410	32.3	550	7.0		4800	5940														
T1		32.3			5 minute taxi																
6	1415	32.3	580	6.5		4980	6080														
T2		37.5			7 minute taxi																
7	1422	37.5	600	8.0		4800	6600														
PP	1427				Park period																
T1	1452	32.3			3 minute taxi																
8	1455	32.3	650	5.7		5520	8580														
T1		32.3			5 minute taxi																
9	1500	32.3	650	6.1		5760	8460														

REMARKS * See temperature curves

EP355

B.F.GOODRICH AEROSPACE & DEFENSE PRODUCTS
Wheel and Brake Plant
Troy, Ohio

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BRAKE TEST LOG

TEST NO. Q-6031

Sheet 7 of 7
Date 4-17-68

REQUIREMENTS:

LANDING VELOCITY As noted mph
STOP TIME As noted sec
STOP DISTANCE -- ft

PRESSURE: 140 psi back
-- psi min.
-- psi max.

OTHER Turn-Around Capability

Stop No.	Log Time	Landing Velocity mph	Brake Press. psi	Stop Time sec	Stop Distance ft	TORQUE Avg. lb ft	TORQUE Peak lb ft	* TEMPERATURES °F Center Stator Initial	Center Stator Peak	Piston Housing Initial	Piston Housing Peak	Torque Plate Initial	Torque Plate Peak	* OTHER PEAK TEMPERATURES °F 4	5	6	7	8	9	10
T2		37.5			7 minute taxi															
10	1507	37.5	650	7.2		4980	7980													
11	1509	157.5	1000	23.0		7200	9780													
	1528	Fuse Plugs blew																		

REMARKS * See temperature curves

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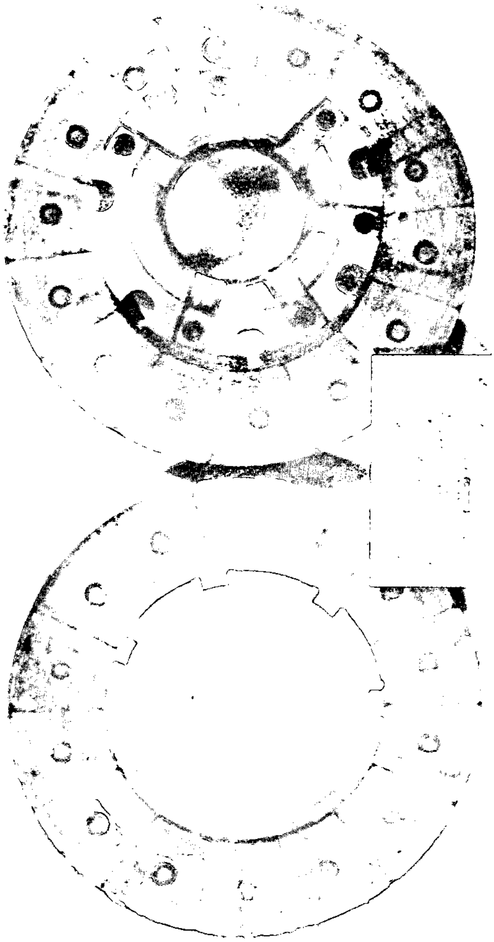
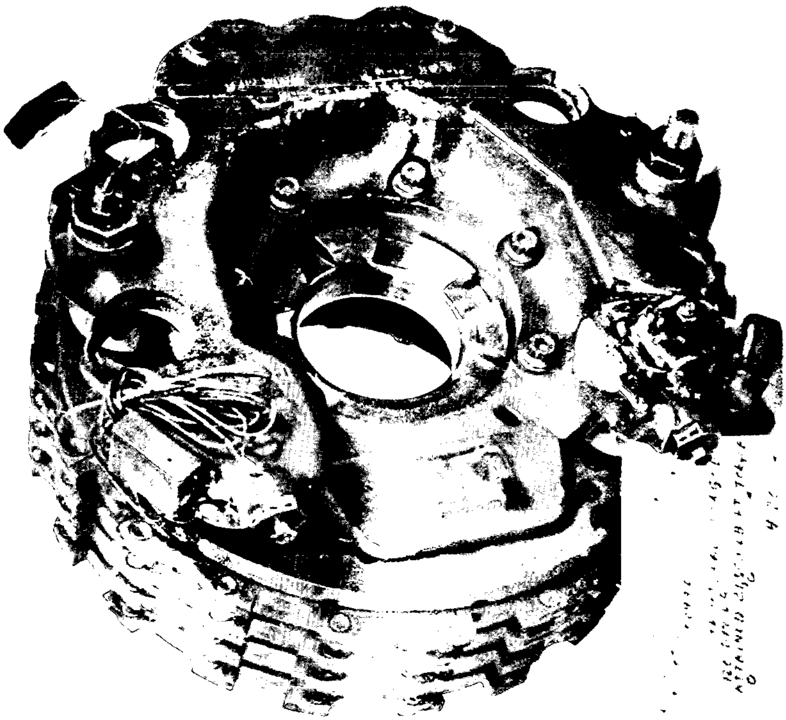
Q-6031



A-197

Q-6031



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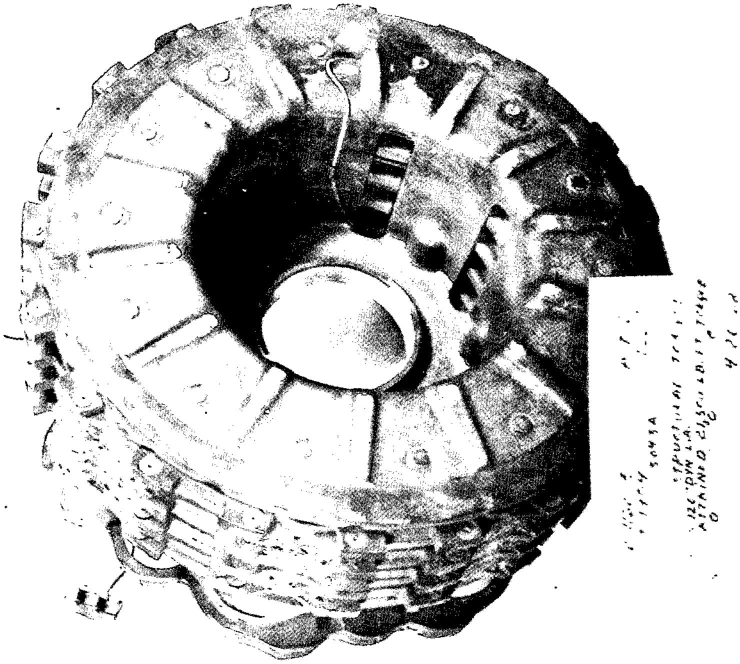
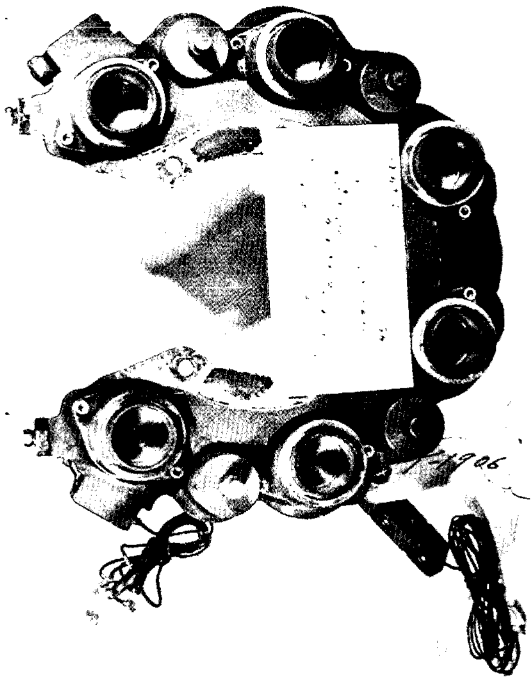
Q-6031



A-199

Q 6031



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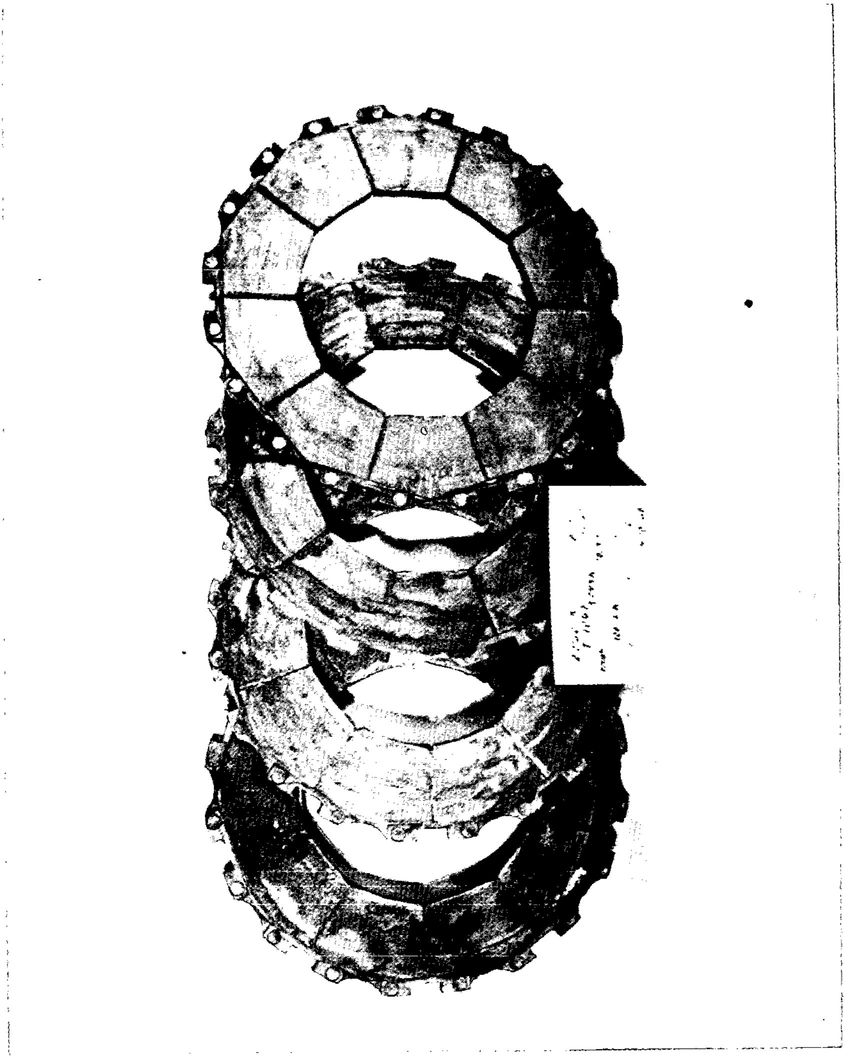

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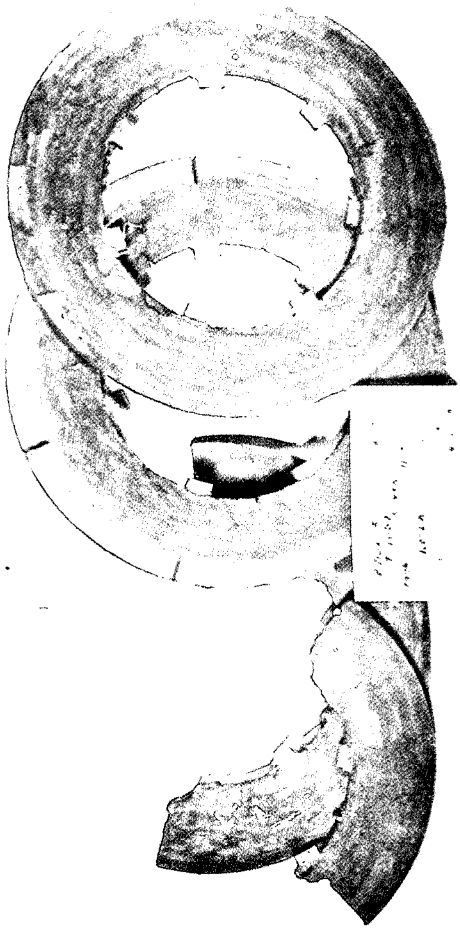
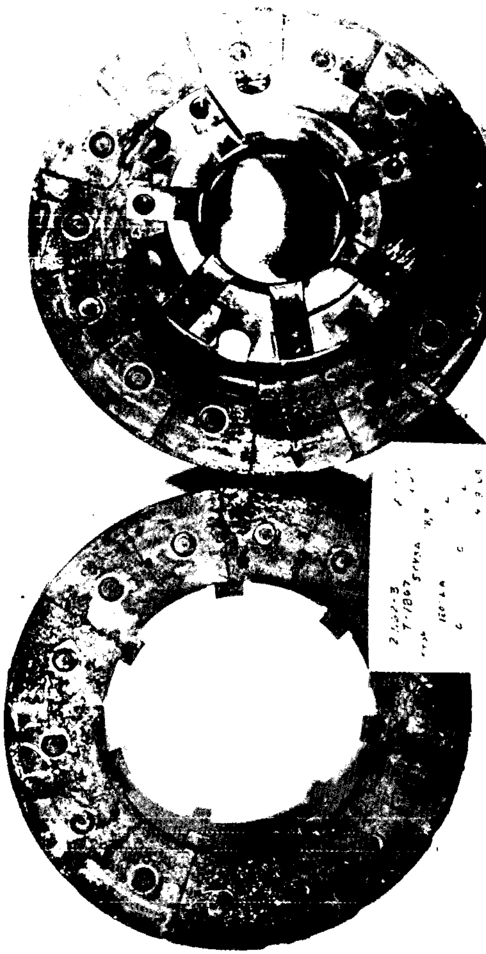


A 192

Q-6031



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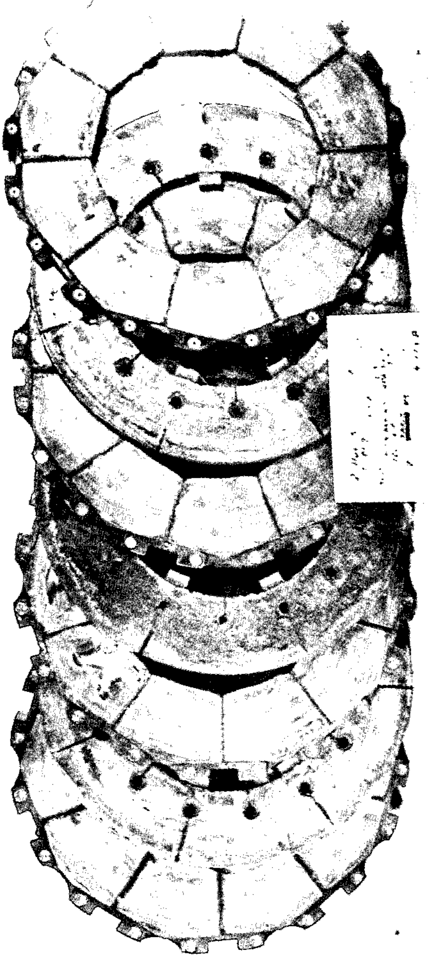
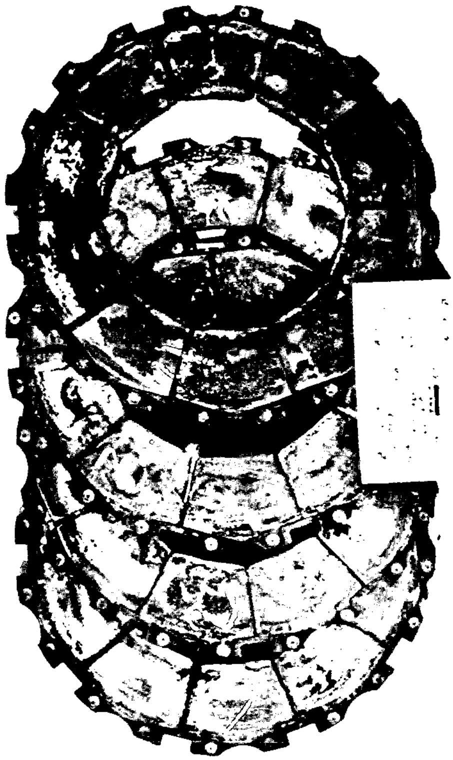


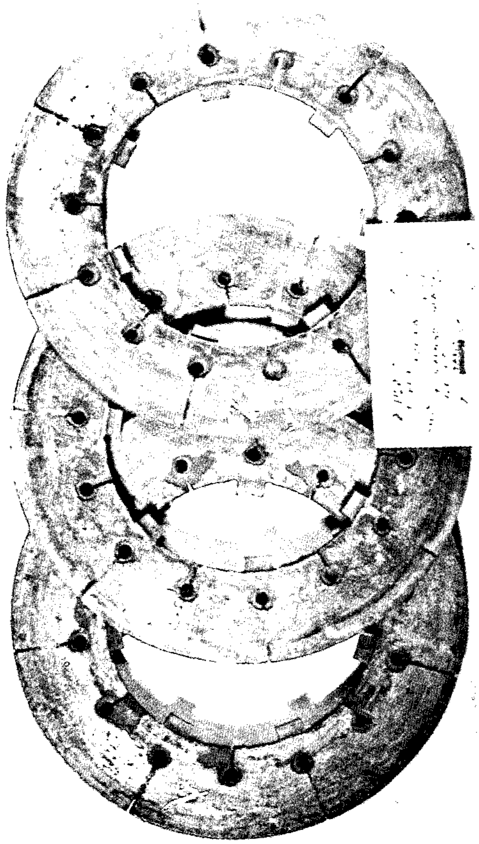
A-194

Q-6031



A 195

Q-6031



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Q-6031

Photograph to be supplied
at later date

Q-6031

Qualification
of the
B.F.Goodrich P/N 2-1162-3
MLG Brake Assembly for the
LTV A7D Aircraft.

May 28, 1968

INTRODUCTION

This report presents the results of qualification tests conducted on the B.F.Goodrich P/N 2-1162-3 MLG brake assembly for the LTV A7D aircraft.

Test procedures and requirements were derived from Military Standard MIL-W-5013G, LTV Specification Document 204-16-37d, and B.F.Goodrich Engineering Report ER-2731 Revision "E".

All tests were conducted at the B.F.Goodrich Wheel and Brake Plant, Troy, Ohio.

Tests were conducted under the following Internal Test Request Numbers:

T-1906-45 stop, 5 stop and worn brake RTO.

T-1867-New brake RTO

T-1572-Extreme temperature, endurance, leakage.

T-1904-New brake peak torque survey, structural torque.

T-1724-Worn brake peak torque survey.

T-1720-Piston housing burst test.

T-1859-Turn around capability test.

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APPENDIX

I CONFIGURATION

Brake assemblies

--B.F.Goodrich P/N 2-1162

Extreme Temperature Tests

Leakage Test

Static Test

--B.F.Goodrich P/N 2-1162-3 Parts list, page A-90

Normal Energy Stops

Overload Stops

Worn Brake RTO

Peak Torque Surveys

Structural Torque

Turn Around Capability

B.F.Goodrich P/N 2-1162-3

Brake Burst Test

B.F.Goodrich P/N 2-1162-3

New Brake RTO

Wheel Assembly

B.F.Goodrich P/N 3-1293-1 Parts List, Page A-91

II TEST EQUIPMENT

Dynamometers

84 inch (Flywheel Diameter) Adamson-United Company
Inertia Equivalent-1797 to 19794 lbs.
Flywheel peripheral speed 0 to 130 mph.
Wheel load to 25000 lbs.
Standard Dynamometer Instrumentation

120 inch(Flywheel Diameter) Adamson-United Company
Inertia equivalent-7511 to 49763 lbs.
Flywheel peripheral speed 0 to 250 mph.
Wheel load to 60000 lbs.
Standard dynamometer instrumentation

II TEST EQUIPMENT

Hydraulic Test Panel

B.F.Goodrich Special Design
Cycle rate 0 to 60 cpm
Pressure-0 to 5000 psi

Hydraulic Pump

Blackhawk Porta Power
0 to 5000 psi

Extreme Temperature Equipment

Blue M Electric Company, Manufacturer

Model FTBR-27-60WC-HEG/1004-27

S/N R2C4-102

Range -100°F to +400°F

Oscillograph

Midwestern Instruments Corp.

Model 621

NS/N

Direct-writing light beam

Tape System

Bell and Howell, Mfr.

14 channel

Model VR-3400

III RESULTS

Before undergoing formal qualification tests, all test specimens were subjected to the standard quality control inspections of the B.F.Goodrich Company and as required by MIL-W-5013G, paragraphs 4.5.1 through 4.5.4.

1. Dynamic Brake Tests

1.1 Normal Energy Stops

a. Specification Reference

MIL-W-5013G, paragraph 4.5.11 and Table 1.

LTV Specification Document 204-16-37d, paragraph 4.3.1.10

BFG ER-2731, Revision "E"

b. Requirements

45 normal energy stops shall be conducted to the conditions presented in Table 1.

TABLE 1

Test Conditions	Energy Condition			
	Normal	Overload	RTO 1*	RTO 2*
Number of Stops	45	5	1	1
KE - ft-lbs x 10^6	12.01	13.95	2.135	18.09
IE - lbs.	18273	16928	18311	18311
Landing Velocity - mph	140.3	156.94	59.0	171.6
Deceleration - f/s/s	9.33	10	10	10
Inflation - psi	270	270	270	270
Wheel Load	18,100	18,100	18,100	18,100
Back Pressure - psi	140	140	140	140

*These 2 stops comprise the RTO condition for the brake. These stops shall be conducted in rapid succession with elapsed time not to exceed 5 minutes.

After normal energy stops 3, 8, 13, 18, 23, 28, 33, 38, and 43 while energy absorbing members are at their peak temperature, increase the brake pressure to 1000 psi. Cooling fans will be turned on when the bead seat temperature reaches its peak value.

After normal energy stops 3, 18, and 38 no cooling shall be used until all peak temperatures are reached in the brake.

Stops 5, 20, 23, 33, and 35 shall be conducted using cooling fans during and after the stop.

It shall be demonstrated before each stop that the brake is free to rotate.

The 45 normal energy stops shall be conducted on one set of friction material.

c. Results

The 45 stops were conducted with the following average results:

Number of stops - 45

KE- 12.01 x 10^6 ft. lbs.

IE - 18273 lbs.

Landing velocity - 140.3

Deceleration - 9.32 ft/sec/sec.

d. Substantiating Data

Brake Test Logs - pages A-1 through A-7, Appendix.

Wear Data Sheets - pages A-11 through A-14, Appendix

Torque, pressure vs time curves
Cooling Profile Curves — pages A-19 through A-42, Appendix.

1.2 Peak Torque Surveys

a. Specification Reference

LTV Specification Document 204-16-37d, paragraph 4.3.1.10.

BFG ER-2731 "E", paragraph 1.4.2.1.1.1.

1.2 Peak Torque Surveys(continued)

b. Requirements

During the course of the 45 normal stop test, the torque development capabilities of the brake shall be determined by conducting maximum pressure stops from speeds of 10, 20, 40, 60, and 100 mph. Tests shall be conducted on both a hot and cold brake, at worn conditions. This will also be conducted on a new brake.

c. Results

Tests were conducted as specified on both a new brake and a worn brake.

d. Substantiating data

Peak torque vs Time curves - pages A-15 through A-18, Appendix.

1.3 Static Torque Test

a. Specification Reference

MIL-W-5013G, paragraph 4.5.11.

BFG ER-2731 "E", paragraph 1.4.2.1.1.2.

b. Requirements

The pressure required to develop a static torque of 113,000 in-lbs. shall be determined during the 45 stop test. The test shall be conducted on the brake:

a. While at room temperature (approximately 70°F)

b. With brake heated bya normal energy stop, the test to be conducted as soon as is practical after the stop.

The above tests shall be performed after stops 4, 23, and 41.

c. Results

Test was conducted as required. Results are shown on static torque log sheet(See Appendix)

d. Substantiating Data

Static Torque Test Log, page A-10, Appendix

1.4 Overload Energy Stops

a. Specification Reference

MIL-W-5013G, paragraph 4.5.11 and Table 1.

BFG ER-2731"E", paragraph 1.4.2.1.2.

b. Requirements

Five overload energy stops shall be conducted to the conditions of Table 1, using the same friction materials as were used for the normal energy stops.

After overload energy stops number 3 and 4 (test stops 48 and 49) no cooling shall be used until all peak temperatures are reached in the brake and in the bead seat. Temperature recordings shall continue until the hottest portion of the brake has cooled to 300°F.

Overload stop number 2(test stop 47) shall be conducted using cooling fans during and after the stop. Temperature recordings shall continue until the hottest portion of the brake has cooled to 300°F.

c. Results

The 5 overload stops were conducted with the following average results:

Number of stops-5

KE - 13.78 x 10^6 ft. lbs.

IE - 16928 lbs.

Landing velocity - 156.1 mph

Deceleration - 8.91 ft/sec/sec.

d. Substantiating Data

Brake Test Log, page A-8, Appendix

Torque Pressure vs Time Curves
Cooling Profile Curves — Pages A-43 through A-62, Appendix

1.5 RTO Stops

a. Specification Reference

MIL-W-5013G, paragraph 4.5.11 and Table 1.

LTV Specification Document 204-16-37d, paragraph 3.3.14.2

BFG ER-2731 "E", paragraph 1.4.2.1.3

b. Requirements

The 2.135×10^6 stop and the 18.09×10^6 stop described in Table 1, comprise the RTO energy condition for the brake. The brake shall have new friction materials for this test.

The 2.135×10^6 stop shall be conducted first and the 18.09×10^6 stop shall be conducted as soon as the dynamometer has achieved the required velocity. This time is not to exceed five minutes.

Fans will not be used until fuse plugs have blown.

This test shall be conducted on both a new brake and a fully worn brake.

c. Results

The test was conducted with the following results:

NEW BRAKE

	RTO 1	RTO 2
KE-	2.135×10^6 ft. lbs.	18.09×10^6 ft. lbs.
IE-	18311	18311
Landing Velocity-	60.4 mph	171.8 mph
Deceleration-	9.13 ft/sec/sec.	9.54 ft/sec/sec.

WORN BRAKE

	RTO 1	RTO 2
KE-	2.209×10^6 ft. lbs.	17.82×10^6 ft. lbs.
IE-	18311	18311
Landing velocity-	60.1 mph	170.7 mph
Deceleration-	6.12 ft/sec/sec.	5.81 ft/sec/sec.

1.5 RTO Stops(continaed)

d. Substantiating Data

Brake Test Logs, pages A-8, A-9, Appendix

1.6 Turn Around Capability

a. Specification Reference

BFG ER 2731"E", paragraph 1.4.2.1.4

b. Requirements

The brake, with new friction materials, shall be subjected to the Test Spectrum of Table 2, three times. The brake shall be cooled to ambient temperature between sequences.

After the three sequences of Table 2 are performed, the sequence of Table 3 shall be conducted.

The energy absorbed by the brake during the 15 minute taxi period shall be simulted by 3 brake stops to the conditions shown in Table 4 for the sequence shown in Table 3, and to the condition shown in Table 5 for the sequence shown in Talbe 2. The deceleration for the taxi stops in Talle 2 will be 8 fps^2 and 6 fps^2 for Table 3.

TABLE 2.

Maneuver	Total Elapsed Time	KE (ft-lbs)	IE (lbs)	Decel. Rate (ft/sec/sec)
* Taxi	15 min.	2.135×10^6	15630	
Fly	25 min.			
Land		11.95×10^6	15630	10
* Taxi	15 min.	2.135×10^6	15630	
Park	30 min.			
* Taxi	15 min.	2.135×10^6	15630	
Fly	25 min.			
Land		11.95×10^6	15630	10
* Taxi	15 min.	2.135×10^6	15630	
Park	30 min.			

Wheel beadseat temperature shall not exceed 350° F and fusible plugs shall remain intact.

NOTE: * Taxi Requirements

1.5 RTO Stops (continued)

TABLE 3

Maneuver	Total Elapsed Time	KE (ft-lbs)	IE (lbs)	Decel. Rate (ft/sec/sec)
* Taxi	15 min.	2.135×10^6	18311	
Fly	25 min.			
Land		11.95×10^6	18311	8.5
* Taxi	15 min.	2.135×10^6	18311	
Park	30 min.			
* Taxi	15 min.	2.135×10^6	18311	
RTO		14.4×10^6	18311	10

*Taxi Requirements

Cooling fans may be used during taxi to simulate 30 knot wind speed and during parking to simulate an 8 knot wind.

TABLE 4
Taxi Requirements

Stops Required	Total Elapsed Time	IE (lbs)	Landing Velocity - mph	KE ft-lbs x 10^6
1	3 min.	18311	32.4	.6402
1	8 min.	18311	32.4	.6402
1	15 min.	18311	37.4	.8552

TABLE 5
Taxi Requirements

Stops Required	Total Elapsed Time	IE (lbs)	Landing Velocity - mph	KE ft-lbs x 10^6
1	3 min.	15630	35	.6402
1	8 min.	15630	35	.6402
1	15 min.	15630	40.5	.8552

c. Results

The test was conducted as specified. Results are shown in graphic form on pages A-78 through A-89, Appendix.

d. Substantiating Data

Cooling Profiles, pages A-78 through A-89, Appendix.

1.7 Structural Torque

a. Specification Reference

MIL-W-5013G, paragraph 4.5.12

LTV Specification Document 204-16-37d, paragraph 3.3.10.

BFG ER-2731"E", paragraph 1.4.2.1.1.3.

b. Requirements

With the brake actuated by maximum operating pressure of 1000 psi, the wheel and brake shall withstand a structural torque of 250,000 in-lbs. without failure. The load shall be applied by means of a belt wrapped around the periphery of the tire. If slippage occurs, the friction forces of the brake shall be pinned or welded. This test shall be performed after the turn-around tests of paragraph 1.6.

c. Results

Test was conducted as specified. A structural torque of 250,200 in-lbs. was pulled with no failure to the brake or wheel assembly.

d. Substantiating Data

Structural Test Log, page A-77, Appendix.

2. Static Brake Tests

2.1 Endurance Test

a. Specification Reference

MIL-W-5013G, paragraph 4.5.15.

BFG ER-2731"E", paragraph 1.4.2.2.2.

b. Requirements

The brake actuation device, using simulated piston loads in lieu of friction materials, shall be required to withstand 100,000 cycles of application and release of normal operating pressures (as defined by MIL-W-5013G, paragraph 6.3.2) and 5,000 cycles at the maximum operating pressure of 1000 psi. The 100,000 cycle portion of this test shall be divided into portions of 25,000 cycles

2.1 Endurance Test ,continued)

b. Requirements(continued)

each with piston loads adjusted to simulate 25, 50, 75, and 100 percent worn conditions respectively, for the four 25,000 cycle portions.

There shall be no leakage or failure during or upon completion of this test.

Before and after the endurance test, pressure required to bring the braking surfaces into initial contact shall be observed and recorded. The minimum pressure at which braking surfaces disengage upon release of pressure shall also be noted and recorded. This test shall be conducted with the brake mounted on the torque flange of a horizontal axle, with the wheel assembly installed.

c. Results

The test was conducted with results shown on the Endurance Test Log(See Appendix).

d. Substantiating Data

Endurance Test Log, pages A-73 and A-74, Appendix.

2.2 ExtrememTemperature Test

a. Specification Reference

MIL-W-5013G, paragraph 4.5.16.1 and 4.5.16.2.

BFG ER 2731"E", paragraph 1.4.2.2.4.1 and 1.4.2.2.4.2

b. Requirements

The brake, filled with operating fluid, shall be subjected to a temperature of 160°F in a thermostatically controlled oven for apperiod of 168 hours with an applied pressure equal to normal operating pressure. Immediately upon removal from the oven and while still at elevated temperature, the brake shall by cycled 1000 times at normal operating pressure, followed by 25 cycles at maximum operating pressure. Leakage at static seals shall not exceed a trace, 2.2. Extreme Temperature Test (continued)

b. Requirements (continued)

and leakage at dynamic seals shall not exceed one drop of fluid per each 3 inches of peripheral seal length.

Upon completion of the aging and heat test, the brake filled with operating fluid at atmospheric pressure shall be subjected to a temperature of -65°F for a period of 72 hours. (See Figure 2) There shall be no leakage during this period. At the expiration of the 72 hours, the brake with fluid entering at a temperature of -65°F shall be cycled 25 times at normal operating pressure, followed by 5 cycles at maximum operating pressure. Leakage shall be limited as above. Brake clearance shall be checked between each cycle to insure complete brake release. The time required for complete brake release shall be ovserved and recorded.

c. Results

Test was conducted to the conditions shown on page A-75, Appendix.

d. Substantiating Data

Extreme Temperature Test Log, page A-75, Appendix.

2.3 Leakage Tests

a. Specification Reference

MIL-W-5013G, paragraphs 4.5.13.1 and 4.5.13.2

BFG ER-2731"E", paragraphs 1.4.2.2.5.1 and 1.4.2.2.5.2

b. Requirements

After completion of the cold test, the brake shall be parked for a period of 5 minutes with an applied pressure of 1500 psi.(one and one half times the maximum operating pressure). The brde shall then be parked for 5 minutes with an applied pressure of 5 psi. There shall be no measureable leakage or permanent set during these tests.

2.3 Leakage Tests(continued)

b. Requirements(continued)

The brake shall be cycled 25 times at maximum operating pressure(1000psi). Leakage at static seals shall not exceed a trace. Leakage at moving seals shall not exceed one drop of fluid per each 3 inches of peripheral seal length.

c. Results

The tests were conducted as required.

There was no leakage or permanent set.

d. Substantiating Data

Hydraulic Pressure Test Log, page A-76, Appendix.

2.4 Static Pressure Test

a. Specification Reference

MIL-W-5013G, paragraph 4.5.14

BFG ER-2731"E", paragraph 1.4.2.2.6

b. Requirements

The brake, with 100 percent worn linings, shall be parked for 5 minutes at twice maximum operating pressure (2 x 1000 = 2000 psi). There shall be no leakage or failure. Pressure shall then be increased undil failure occurs. Pressure at failure shall be recorded.

c. Results

There was no leakage when pressure of 2000 psi was applied to the brake for 5 minutes.

Pressure was increased to 3170 psi before failure occured.

d. Substantiating Data

Hydraulic Pressure LTest Log, Page A-76, Appendix.

2.5 Salt Test

a. Specification Reference

BFG ER-2731"E", paragraph 1.4.1.6

b. Requirements

The brake shall undergo the salt spray test of MIL-STD-810A, Method 509.1, Procedure I.

c. Results

The test was conducted as required. There was no detrimental effects on the brake.

d. Substantiating Data

Test Log, Page A-90, Appendix.

IV CONCLUSION

The B.F.Goodrich P/N 2-1162-3 brake assembly does not meet the intent or the requirements of the applicable specification documents and therefore is not qualified.

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Wheel and Brake Plant
Troy, Ohio

TEST RESULTS

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SUBJECT BRAKE ASSEMBLY COMPLETED FORTY-FIVE (45) NORMAL ENERGY STOPS, FIVE (5) OVERLOAD ENERGY STOPS AND A SMALL & A LARGE R.T.O.

DURING THE PURSUIT OF THIS TEST, THE FOLLOWING DEVIATIONS FROM THE TEST PLAN & TEST SPECIFICATION WERE EXPERIENCED:

(1.) FOLLOWING STOP NO. 48 THE FUSE PLUG EUTECTIC MATERIAL MELTED SUFFICIENTLY SO AS TO ALLOW THE TIRE TO SLOWLY DEFLATE. SUCH OCCURRENCE REQUIRED WHEEL DIS-ASSEMBLY AND REPLACEMENT OF THE FUSE PLUG.

(2.) FOLLOWING STOP NO. 49 THE FUSE PLUG EUTECTIC MATERIAL MELTED ENTIRELY & RELEASED COMPLETELY THUS ALLOWING THE TIRE TO DEFLATE. SUCH OCCURRENCE REQUIRED WHEEL DIS-ASSEMBLY AND REPLACEMENT OF THE FUSE PLUG.

(3.) BRAKE PRESSURE WAS RELEASED ON THE BRAKE WHEN THE VELOCITY REACHED 10 - 15 MPH., THEREBY ALLOWING THE WHEEL TO COAST TO A STOP. STOP TIMES WERE COMPUTED FROM THE BRAKE ON VELOCITY TO THE BRAKE OFF VELOCITY. THIS MODIFICATION OCCURRED DURING THE FORTY-FIVE (45) NORMAL ENERGY AND FIVE (5) OVERLOAD ENERGY STOPS.

THE FOLLOWING ABNORMAL PROCEDURES ALSO OCCURRED:

(4.) STATORS NO. 1 AND NO. 3 WERE PHYSICALLY SWITCHED (REVERSED POSITIONS) AFTER STOP NO. 30 AND REMAINED IN THESE POSITIONS THROUGH THE CONCLUSION OF THE TEST.

(5.) THE FIVE (5) OVERLOAD STOPS WERE CONDUCTED WITH A LINING CARRIER (P/N 261-268) PLACED BETWEEN THE

Test Engineer

Date

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PISTON HOUSING AND THE PRESSURE PLATE. THIS ADDITIONAL PART WAS REQUIRED TO ENSURE SUFFICIENT PISTON TRAVEL. THE FOUR (4) ADJUSTERS WERE REMOVED AND AS A RESULT, LOWER VISIBLE BRAKE PRESSURE WAS REQUIRED TO CONDUCT THE STOPS. TOTAL AVAILABLE PRESSURE FOR THE BRAKE WAS NOT EXCEEDED.

(6) THE R.T.O. WAS CONDUCTED WITH A USED PRESSURE PLATE (P/N 93-394) PLACED BETWEEN THE PISTON HOUSING AND THE PRESSURE PLATE ASSEMBLY. THIS ADDITIONAL PART WAS REQUIRED TO ENSURE SUFFICIENT PISTON TRAVEL. THE FOUR (4) ADJUSTERS WERE INSTALLED.

(7) PRIOR TO THE R.T.O., THE INSIDE DIAMETER OF THE THREE (3) LINING CARRIERS WAS INCREASED 0.120 INCHES TO ALLEVIATE THE SHRINKAGE OF THE LINING CARRIERS ON THE TORQUE TUBE.

(8) AFTER STOPS NO. 10, 20, 30, 40, 45, & 50, THE BRAKE WAS DIS-ASSEMBLED. THE EXPANSION SLOTS IN THE LINING CARRIERS WERE CLEANED OF EXCESS MATERIAL AND OPENED. EXCESS MATERIAL WAS REMOVED FROM BETWEEN THE SEGMENTS IN THE ROTORS.

IN VIEW OF THE AFOREMENTIONED, IT IS THE WRITERS OPINION THAT SUBJECT BRAKE ASSEMBLY IS NOT A FULLY QUALIFIED ITEM.

R. Glen
Test Engineer

27 MAY 68
Date

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Sheet 2 OF

DATE	SIGNATURE	SPECIAL TEST REQUIREMENTS AND PROCEDURES
5/2/68	R. Glover	TWO COOLING FANS WILL BE USED, ONE STATIONARY REAR FAN
		AND ONE MOBILE FAN PLACED DIRECTLY IN FRONT OF THE WHEEL
		SO AS TO BLOW DIRECTLY INTO THE WHEEL FROM THE O/B
		SIDE. THIS MOBILE FAN WILL BE PLACED APPROXIMATELY 8 FT. FROM WHEEL.
5/2/68	R. Glover	THE OPERATOR WILL VARY THE PRESSURE ACCORDINGLY SO AS TO
		MAINTAIN STOP TIME.
5/2/68	R. Glover	INFLATION PRESSURE OF 270 PSI IN THE WHEEL IS CHANGED
		TO 313 PSI NITROGEN TO ALLOW FOR ROADWHEEL CURVATURE.
5/2/68	R. Glover	CLEAN THE ROADWHEEL & CHECK INFLATION PRESSURE PRIOR TO
		EACH STOP.
5/2/68	R. Glover	ALL OSCILLOGRAPH DATA WILL BE RECORDED IN THE DATA ROOM.
5/2/68	R. Glover	USE 1000 PSI IN BRAKE WHEN CONDUCTING FLUID DISPLACEMENT.
5/2/68	R. Glover Per [illegible]	BLOW OUT LINING DUST AFTER WI. STOP #4 & CLEAN ROADWHEEL
5/3/68	Burgess Per R. Glover	OMIT HOT FLUID DISPLACEMENT AFTER #1 NORMAL
5/3/68	Burgess Per R. Glover	USE 700 PSI. FOR FIRST NORMAL
5/3/68	Burgess	CHECK TIRE FOR RUBBER BUILD-UP PRIOR TO NORMALS & CLEAN IF NECESSARY

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Sheet 1 OF

DATE	SIGNATURE	SPECIAL TEST REQUIREMENTS AND PROCEDURES
5/1/68	R. Glen	INSTALL DISKS ON TORQUE PLATE WITH LINKS FACING UP.
5/2/68	R. Glen	THE DATA ROOM WILL BE USED IN SUPPORT OF ALL STOPS (EXCLUDING WEAR-INS). THE DATA ROOM TECHNICIAN WILL TELL THE OPERATOR WHEN TO LAND THE WHEEL & WHEN TO APPLY THE BRAKES. THE OPERATOR WILL SET THE HYDRAULIC BRAKE PRESSURE ACCORDING TO WHAT IS RECORDED IN THE DATA ROOM (NOT THE PANEL). THE DATA TECHNICIAN WILL GIVE THE OPERATOR THE FOLLOWING INFORMATION WHICH WILL BE RECORDED ON THE LOG SHEETS: ① STOP TIME, ② BRAKES ON SPEED. THE OPERATOR WILL LEAVE OPEN THE SPACES FOR TORQUE (PEAK & AVERAGE), PRESSURE, DISTANCE, & #1 ROTOR & STATOR AS THESE WILL BE REDUCED FROM THE TAPE & SUPPLIED AT A LATER TIME.
5/2/68	R. Glen	THE OPERATOR IS REQUIRED TO WATCH THE SPEED CHART DURING THE STOP & WHEN THE VELOCITY REACHES APPROXIMATELY 10 MPH, THE PRESSURE ON THE BRAKE WILL BE RELEASED AND THE WHEEL ALLOWED TO COAST. A SHORT TAXI ~~[illegible]~~ IS TO RUN AFTER EACH STOP, TAXI VELOCITY TO BE 10 MPH FOR 10-15 SECOND DURATION.

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B.F. GOODRICH AEROSPACE & DEFENSE PRODUCTS
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Sheet 3 OF

DATE	SIGNATURE	SPECIAL TEST REQUIREMENTS AND PROCEDURES
5/3/68	R. Glon.	DATA ROOM SUPPORT REQUIRED ON ALL STOPS.
~~5/3/68~~	~~R. Glon~~	~~GET HOT DISPLACEMENT BEFORE STOP #2.~~ R.G.
5/3/68	R. Glon.	HAVE THE DATA ROOM RUN THE TAPE FOR AT LEAST ONE MINUTE
		AFTER EACH STOP TO OBTAIN PEAK TEMPERATURES. (THEY MAY RUN
		THE TAPE LONGER IF PEAKS HAVEN'T OCCURRED & THEY HAVE TIME.)
5/3/68	R. Glon.	DELETE ALL REQUIREMENTS FOR HOT FLUID DISPLACEMENT. THE
		OPERATOR IS REQUIRED TO OBTAIN COLD FLUID DISPLACEMENT WHERE
		SPECIFIED ON THE TEST REQUEST.
5/3/68	R. Glon.	EFFECTIVE STOP 3 & UP: SET WHEEL LOAD @ 20,000 LBS. ~~SET~~ SET
		R.R. STOP @ 11.0 INCHES THEREBY ALLOWING WHEEL TO FLOAT.
5/3/68	R. Glon	USE BRAKE PRESSURE OF 700 PSI FOR STOP #3.
5/3/68	R. Romie	HOT PARK AFTER STATIC TORQUE AFTER STOP #4
5/6/68	R. Glon.	CHANGE TIRE AFTER STOP #7
5/6/68	R. Glon.	AT THE 10 STOP BRAKE TEAR DOWN, INSTALL A SECOND T'COUPLE IN
		THE #1 STATOR. LOCATE THE T'COUPLE APPROX 1" FROM THE EXISTING
		T'COUPLE IN THE LUG & DRILL IT APPROX 3/4" DEEP. DRILL A 1/4" HOLE

IN THE TORQUE TUBE TO EXIT THE T'COUPLE LEAD & RUN IT UP TO THE DATA ROOM. AS A RESULT OF THIS, THERE WILL BE 2 T'COUPLES IN THE

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DATE	SIGNATURE	SPECIAL TEST REQUIREMENTS AND PROCEDURES
5/8/68	PER R. GLOOR B.A. Burgess	TAPE SYSTEM NOT WORKING. CONTINUE STOPS TILL FIXED.
5/5/68	R. Gloor.	AT 20 STOP TEARDOWN CHANGE TIRE.
5/8/68	R. Gloor.	AT 20 STOP TEARDOWN, DRILL T'COUPLE HOLE IN #1 STATOR & #1
		ROTOR APPROX 1 3/16" DEEP & INSTALL T'COUPLE WIRE USING SPECIAL
		EPOXY AS SUPPLIED BY THE WRITER. ALLOW THE EPOXY TO CURE IN
		A 250°F OVEN (MIN TEMP.) FOR 2 HOURS (MIN TIME) RE-ASSEMBLE
		BRAKE & RESUME TEST. REPLACE (OR REPAIR) ALL OTHER T'COUPLES
		PER NORMAL INSTALLATION PROCEDURE.
5/10/68	R. Gloor	RETAKE BRAKE CLEARANCE AFTER STOP #30.
5/10/68	R. Gloor.	CHANGE TIRE AFTER STOP NO. 32.
5/10/68	R. Gloor.	AT THE STOP #30 BRAKE TEAR DOWN, HAVE THE HEAT STACK
		COMPONENTS PHOTOGRAPHED BEFORE W&M & CLEAN UP.
5/10/68	R. Gloor.	USE SAME PROCEDURE FOR RE-INSTALLING T'COUPLES AS OUTLINED
		FOR STOP #20 TEARDOWN.

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B.F. GOODRICH AEROSPACE & DEFENSE PRODUCTS
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DATE	SIGNATURE	SPECIAL TEST REQUIREMENTS AND PROCEDURES
5/10/68	R. Glor. X	At the stop #30 tear down, switch the #1 stator to the #3 stator position & the #3 stator to the #1 stator position. Install T'couples in the new #1 stator as req'd.
5/10/68	Blair	Permissable to run stop #31 without fuse plug tepl.
5/11/68	R. Glor	Run stop #33 using ~~[illegible]~~ 800 PSI in brake per S. Lawson.
5/13/68	R. Glor.	At the stop #40 brake tear down, re-install T'couples as defined at the stop #20 brake tear down. Repair and/or replace T'couples as req'd. Re-assemble heat stack as defined during ~~[illegible]~~ the stop #30 brake tear down.
5/14/68	R. Glor.	At completion of 45 stops tear down brake & w&m.
5/14/68	S.J.L.	Place spacer between P.P. and Pistons, Measure piston extension from end of sleeve to spacer on all six pistons before start of 5 stop test using 850 to 900 PSI, and after 5 stop test.
5/14/68	R. Glor.	Remove adjusters to install spacer & re-install P.P. T'cpl to line up properly with spacer.

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DATE	SIGNATURE	SPECIAL TEST REQUIREMENTS AND PROCEDURES
5/14/68	R. Glon.	REPLACE T'CPLES AS REQ'D PRIOR TO START OF OVERLOAD STOPS.
5/21/68	1330 hours S.J. Lawson	① On stops 48 & 49 no cooling shall be used during or after the stop until all peak temperature are reached. ② On ALL stops let the temperature charts run for one (1) hour minimum. Mark the actual time (hours & minutes) on each chart before each stop.
5/21/68	R. Glon.	THE OPERATOR WILL NOT RECORD THE STOP TIME (FURNISHED BY THE DATA ROOM) IN THE LOG SHEET; HE WILL LEAVE THE STOP TIME & TORQUE COLUMNS BLANK. BRAKES ON VELOCITY WILL BE RECORDED. (THIS PERTAINS TO THE OVERLOAD ENERGY STOPS) BRAKE PRESSURE WILL BE SET BY & RECORDED ACCORDING TO THE DATA ROOM.
7/2/68	R. Glon.	TIRE INFLATION CORRECTED FOR 120" DYN IS 295 PSI NITROGEN

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Sheet 7

DATE	SIGNATURE	SPECIAL TEST REQUIREMENTS AND PROCEDURES
7/21/68	1600 hours D. Lawson	take fluid displacement with 100 psi locked in brake.
5/21/68	R. Glon.	POSITION 1 FAN TO BLOW INTO BRAKE FROM O/B WHEEL SIDE ABOUT 6 FEET AWAY FROM WHEEL.
5/21/68	R. Glon.	REMOVE WHEEL FROM BRAKE AFTER EACH O.L. STOP & BLOW EXCESS LINING DUST FROM B/T HEAT STACK ELEMENTS.
5/21/68	R. Glon.	~~DO NOT REMOVE WHEEL AFTER 1st O.L. STOP. ROTATE WHEEL BY HAND & INSERT AN AIR HOSE INTO THE BRAKE FROM EACH SIDE OF THE WHEEL TO BLOW OUT DUST.~~ R.G.
5/21/68	R. Glon.	CHECK & MAINTAIN TIRE PRESSURE OF 295 PSI PRIOR TO EACH O.L. STOP. CLEAN ROADWHEEL B/T STOPS.
5/21/68	R. Glon.	~~STEP~~ USE 770 PSI IN BRAKE FOR 1st O.L. STOP. MAX ALLOWABLE BRAKE PRESSURE DURING O.L. PHASE OF TEST IS 860 PSI.
5/21/68	R. Glon.	FOR O.L. STOPS: DUMP PRESSURE ON BRAKE WHEN VELOCITY REACHES APPROX 10 to 15 MPH. TAXI WHEEL AFTER THE STOP.
5/21/68	R. Glon.	XFER THE CENTER STATOR & #2 ROTOR T'COUPLES FROM PORTABLE 2-PEN RECORDER TO THE 84" DYN 2-PEN RECORDER.

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DATE	SIGNATURE	SPECIAL TEST REQUIREMENTS AND PROCEDURES
5/21/68	R. Glen.	DO NOT REMOVE WHEEL AFTER STOP #47. RUN STOP #48
		W/O REPLACING DEFECTIVE T'COUPLES. USE AN AIR HOSE TO BLOW
		OUT LINING DUST IN BRAKE AS BEST AS YOU CAN.
5/21/68	2330 hrs S.J. Lawson	Run overload stop number #3 at 2335 hrs @ 820 PSI.
5/22/68	0110 hrs S.J. Lawson	change tire and fuse plugs after stop #48
5/22/68	B. Burgess Per S.J. Lawson	RUN REMAINING O.L. STOPS W/OUT #1 ROTOR T/C (DATA ROOM)
5/23/68	R. Glen	FOR R.T.O.: REMOVE SPACER (USED DURING O.L.) & INSTALL A P.P. (AS FURNISHED BY
		WRITER) B/T ORIG P.P. & P.H. REINSTALL ADJUSTORS.
5/23/68	R. Glen	INSTALL NEW T'COUPLES IN WHEEL & BRAKE FOR R.T.O.
5/24/68	R. Glen.	TAKE FLUID DISPLACEMENT PRIOR TO R.T.O.
5/24/68	R. Glen. X	USE A FILE TO REMOVE LINING MAT'L THAT HAS EXTRUDED
		FROM LINING SEGMENTS ON TORQUE PLATE. O.D.
5/24/68	R. Glen.	USE 600 PSI FOR 2×10^6 RTO & 1000 PSI FOR 18×10^6 RTO

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OPERATOR'S COMMENTS

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DATE	OPERATOR	REFERENCE	COMMENTS
5-2-68	BH	BRAKE CLEARENCE	BEFORE TEST WAS ① .101 ② .101 ③ .101 ④ .101
5-2-68	BH.	DISPLACEMENT	" " " 28 ML @ 1000 PSI.
5-3-68	RB	Drag	Drag after dust was blown out Prior to #1 normal was 2 lbs.
5-3-68	RB	inf. Press	inf. Press was 297 P.S.I. prior to stop #1 — re-inflated to 313 P.S.I.
5-3-68	RB	displ.	Hot fluid displacement was not taken after stop #1
5-3-68	LES	SKID stop #2	WHEEL SKIDDED AT 25 MPH DURING STOP #2 (STOP TIME EXTRAPOLATED TO 10 MPH)
5-3-68	BH	INF. PSI.	INF PSI BEFORE STOP #4 WAS 290 PSI. REINF TO 313 PSI.
5-3-68	BH	COOLING PROFILE	HOT PARK WAS RAN AFTER HST AFTER STOP #4
5-3-68	BH	INF PSI.	INF PSI BEFORE STOP #5 WAS 308 PSI. REINF TO 313 PSI.
5-3-68	BH.	AFTER STOP #5	TANGENTIAL FORCE TO MOVE WHEEL WAS 4 Lbs. With Fishscale
5-6-68	RB	delay	Stop #6 delayed due to fan Problem & waiting on Data Room
5-6-68	RB	Inf Press	Inf press prior ~~296~~ to stop #6 was 296 P.S.I. — reinflated to 313 P.S.I.
5-6-68	RB	delay stop #7	Nuts on Roadwheel viberated loose — Stopped Test to re-Align Plates on
—	—	—	road wheel
5-6-68	RB	Inf. Press	Inflation Press. was 313 P.S.I. prior to Stop #7 - Wheel was free to Turn
5-6-68	LES	TIRE & STOP 8	CHANGED TIRE BEFORE STOP #8 BRAKE FREE INFLATION 313 PSI
			STOP DELAYED DUE TO TIRE CHANGE, T/C REPAIR & DATA ROOM DELAY.
5-6-68	BH	INF. PSI	INF. PSI. BEFORE STOP #9 290 PSI REINF TO 313 PSI. WHEEL TURNS FREELY
5-6-68	BH	BRK. CLEARENCE	AFTER STOP #9 WAS ① .156 ② .156 ③ .156 ④ .156
5-6-68	BH	INF PSI	INF PSI BEFORE STOP #10 WAS 305 PSI. REINF. TO 313 PSI. WHEEL TURNS FREELY
5-6-68	BH.	DRAG AFTER STOP #10	TANGENTIAL FORCE TO MOVE WHEEL WAS 4 lbs.
5-6-68	BH	DISPLACEMENT	COLD DISPLACEMENT AFTER STOP #10 WAS 39.5 ML @ 1000 PSI BEFORE CLEANING
5/7/68	RB.	DISPLACEMENT	COLD - AFTER STOP #10 & AFTER BRAKE WAS CLEANED. w/1000 PSI. 41 ML.
5-7-68	RB	Inf. Press	Inf. Press was 305 P.S.I. prior to Stop #11 - was Re-inflated to 313 P.S.I. - was free to Turn
5-7-68	RB	Thermocouples	installed second T.C. in #1 stator per Special Request 5/6
5-7-68	HLH	Thermocouples	Installed new T.C. in #1 & #2 Rotors after Stop #11
5-7-68	HLH	Inf Press.	Inflation Press. Before Stop #12 310 P.S.I. wheel free.
5-7-68	BH	INF PSI	" " " " #13 314 PSI WHEEL TURNS FREELY
5-7-68	BH	INF PSI	" " " " #14 WAS 310 PSI REINF TO 313 PSI.
5-7-68	BH.	DEFLATED TIRE	BEFORE STOP #14 TO RE INSTALL BEAD SEAT T/C.

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Sheet No. #2 oF

OPERATOR'S COMMENTS

DATE	OPERATOR	REFERENCE	COMMENTS
5-7-68	RAH	TIRE INF PSI	BEFORE STOP# 15 WAS 300 PSI. REINF TO 313 PSI. WHEEL TURNS FREELY
5-7-68	RAH	NOT ON TAPE	STOP# 15 NOT ON TAPE DUE TO DATA ROOM HAVING TO PUT ON CLEAN TAPE
—	—	—	WOULD DELAY STOP FOR 1 HR OR MORE PER BILL ARTHUR.
5-8-68	RB	Drag	Drag Prior To Stop #16 was 4 lbs.
5-8-68	RB	inf. Press	inf. Press. was 313 lbs prior To Stop #16
5-8-68	RB	Ø Tape	due To data Tape problems - Stop #16 was ran without Tape
5-7-68	RB	Torque Plate	Segements on Torque plate were loose at #10 Tear down
—	—	—	re-Tightened Them before reassembling
5-8-68	RB	inf. Press.	inf Press was 305 - reinflated To 313 P.S.I. — was free To Turn.
5-8-68	RB	inf. Press	infl. Pres was 305 P.S.I. - re-inflated To 313 P.S.I. - was free To Turn
5-8-68	[illegible]	CLEARANCE	AFTER STOP # 18 ① .115 ② .115 ③ .115 ④ .115
5-9-68	RB	delay	Set-up for Stop #21 delayed To Change IE on 120" Dyn
5-9-68	RB	inf. Press.	Tire Changed & Re inflated To 313 P.S.I. for Stop #21 - was free To Turn
5-9-68	RB	inf. Press	inf. Press. was 280 P.S.I. prior To Stop #22 - inflated To 313 P.S.I.
5-9-68	RB	drag	3 lbs. of Drag prior To Stop #22
5-8-68	RAH	TIRE CHANGE	TIRE WAS CHANGED AFTER STOP #20
5-8-68	RAH	T/C IN #1	STATOR & #1 ROTOR PUT IN 1 3/16 DEPTH WITH CERAMABOND AND
—	—		CURED IN OVEN PER INSTRUCTIONS
5-9-68	RAH	DRAG & TIRE PSI.	TIRE PSI BEFORE STOP 25 WAS 315 PSI. WHEEL TURNS FREELY.
5-9-68	RAH	NO TAPE ON STOP #25	Bill Arthur said tape did not print on this stop.
5-9-68	RAH	DELAY ON STOP #26	TO SPLICE T/C THAT WAS INSTALLED WITH CERAMABOND AND TO
—	—	CHECK OUT	STATOR T/C INSTALLED WITH CERAMABOND. DATA ROOM HAD SOME TROUBLE ON THIS
5-9-68	RAH	TIRE PSI	BEFORE STOP #26 WAS 310 PSI. REINF. TO 313 PSI. DRAG WAS 4 lbs.
5-9-68	RB	inf. Press	inf. Press was 305 P.S.I. prior To Stop #27 - wheel was free To Turn
5-10-68	RB	Clearance	after Stop #27 Clearance was ① .328 ② .423 ③ .441 ④ .401
5-10-68	RB	inf. Press	inflation Press. was 295 P.S.I. prior To Stop #28 - inflated To 313 P.S.I. - Wheel was free
5-10-68	RB	inf. Press	inflation Press. was 305 P.S.I. prior To Stop #29 - inflated To 313 P.S.I. — wheel was free
5-10-68	LES	DRAG	TOOK 2 LBS TO TURN WHEEL BEFORE STOP #30
5-10-68	LES	CLEARANCE	AFTER STOP #30 ① .115 ② .115 ③ .115 ④ .115

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OPERATOR'S COMMENTS

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DATE	OPERATOR	REFERENCE	COMMENTS
5-10-68	BH	SWITCHED #3	STATOR WITH #1 AND INSTALLED 1 T/C IN LUG AND 1 T/C
—	—	—	BETWEEN LUGS W/ CERAMABOND. ALSO INSTALLED NEW T/C IN #1 ROTOR
—	—	—	W/ CERAMABOND.
5/10/68	BH	TIRE PSI	TIRE PSI BEFORE STOP #31 WAS 305 PSI. REINF TO 313 PSI. WHEEL TURNS FREELY.
5/11/68	R. Blow.	STOP #33	PRIOR TO STOP, TIRE CHANGED & FUSE PLUG & BEAD SEAT T'COUPLE REPLACED
			ROAD WHEEL CLEANED & BRAKE BLOWN OUT. WHEEL HAS SOME DRAG
5/11/68	BH	STOP #34	TIRE PSI. WAS 290 PSI. BEFORE STOP #34 REINF. TO. 313 PSI. DRAG IS 18 Lbs.
5/11/68	BH	DRAG AFTER	STOP #34 WAS 10 Lbs
5/11/68	BH	TUBEWELL T/C	WAS READING LOW FOUND BARE WIRES WHERE IT IS INSTALLED IN
—	—	—	HYSOL. COULD NOT REPLACE SO TAPED BARE WIRES
5/12/68	OS	TIRE PSI	Prior to stop #35 TIRE psi WAS 313 psi ~~[illegible]~~
—	—	—	RAN COOLING PROFILE ON stop #35.
5/12/68	BH	TIRE PSI + DRAG	TIRE PSI BEFORE STOP #36 WAS 311 PSI. DRAG WAS 8 Lbs
5/12/68	BH	BRK. CLEARANCE	AFTER STOP #36 WAS ①.135 ②.135 ③.135 ④.135
5/12/68	BH	TIRE PSI + DRAG	BEFORE STOP # 37 TIRE INF PSI WAS 315 PSI. BRAK DRAG WAS 10 Lbs.
5-13-68	RCB	inf. Press.	inf. Press was 313 P.S.I. Prior To Stop #38
5-13-68	RCB	Drag	Drag was 12 Lbs prior To Stop #38 after blowing dust out of brake
5-13-68	RCB	inf. Press & Drag	inf. Press. was 310 P.S.I. & Wheel had 8 Lb. Drag Prior To Stop #39
5-13-68	RCB	fans	Noticed after Stop #39 That portable fan was un-plugged.
5/13/68	BH	CERAMABOND IN T/Cs	ON #3 STATOR Which is Now #1 CERAMABOND USED TO INSTALL
—	—		NEW T/C BETWEEN THE LUGS ALSO NEW T/C CERAMABONDED IN #1 ROTOR
5/13/68	BH	T/Cs IN STACK	WERE REPLACED by DAY SHIFT. ALL OTHERS IN WORKING ORDER
5/13/68	BH	TIRE PSI + DRAG	TIRE PSI BEFORE STOP #41 WAS 308 PSI. REINF TO 313 PSI. DRAG WAS 8 Lbs.
5-14-68	RCB	delay	Stop #42 Delayed To replace T.C. in #2 Rotor
5-14-68	RCB	inf. Press.	inf. Press. prior To Stop #42 was 313 P.S.I.
5-14-68	RCB	" "	" " " " " #43 " " "
5-14-68	RCB	delay	Stop #44 Delayed To Replace T.C. in #2 Rotor & To wait on DATA Room
5-14-68	[illegible]	DISPLACEMENT	DISPLACEMENT AFTER STOP # 45 W/1000 PSI COLD WAS 37 ML
5-14-68	R. Blow.	TOTAL WT.	AFTER STOP #45, TOTAL BRAKE WEIGHT W/ T'CPLS 97.9 LBS. (W/FLUID IN BSG.)

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B.F.GOODRICH AEROSPACE & DEFENSE PRODUCTS
Wheel and Brake Plant
Troy, Ohio

TEST NO. T-1906

OPERATOR'S COMMENTS

Sheet No. #4 oF

DATE	OPERATOR	REFERENCE	COMMENTS
5-21-68	CW	DISPLACEMENT	COLD BEFORE #1 OVER LOAD. OR STOP #46 FROM 900 PSI TO 0 PSI
5-21-68	CW	AFTER STOP #46	WHEEL WAS PULLED AND 4-TH ROTOR THERMOCOUPLES HAD TO BE REPLACED HAVING TROUBLE WITH TWO PEN RECORDER. TOO AT THIS TIME BRAKE WAS CLEANED OUT WITH FORCED AIR. TIRE PRESS WAS 270 PSI REINFLATED TO 295 PSI ~~[illegible]~~ TWO PEN MOVED TO 84" DYNA, TWO PEN.
5-21-68	CW	AFTER STOP #47	BRAKE WAS CLEANED WITH FORCED AIR — WHEEL WAS PULLED AND THERMOCOUPLES ON THE ROTORS WAS REPLACED. TIRE PSI WAS OKAY.
5-22-68	Jew	FUSE PLUG	LEAKING AFTER STOP 48 AT APPROX. 00:05 (5-22-68)
5-22-68	Jew	DELAY	CHANGE TIRE & REPLACE FUSE PLUGS. DISCUSSION OF NON WORKING THERMO (TO DATA ROOM). DELETE THERMO ~~[illegible]~~ BECAUSE OF TIME ELEMENT (PER BBENZIES PHONE CALL TO LAWSON AT 04:15, 5-22-68.)
5-22-68	Jew	FUSE PLUG	BLEW AFTER STOP 49 WAS RAN
052268	R. Glenn	BRAKE WT.	TOTAL BRAKE WT AFTER O.L. STOP #5 (INCLUDES FLUID IN P.H., T/C WIRES & PLUGS, & SPACER & NO ADJUSTERS) WAS 98.8 LBS.
052268 ~~052468~~	R. Glenn ~~R. Glenn~~	WEIGHT	TOTAL BRAKE WT AFTER O.L. STOP #5 (DOESN'T INCLUDE T'COUPLES, FLUID, OR SPACER) WITH ADJUSTERS & HT. STACK IS 95.6 LBS.
052468	R. Glenn	FLUID DISP.	PRIOR TO R.T.O. WITH 100 PSI. FLUID DISP. IS 30 ML.
052468	R. Glenn	WEIGHT	AFTER R.T.O. BRAKE WT. (INCLUDES T/C, FLUID, ADJUSTERS, & P.P. SPACER) WAS 102.0.
052768	R. Glenn	WEIGHT	AFTER R.T.O., BRAKE WT. W/O P.P. SPACER (INCLUDES T/C, ADJUSTERS, & FLUID) WAS 95.3 LBS.

EP65

B.F.GOODRICH AEROSPACE & DEFENSE PRODUCTS
Wheel and Brake Plant
Troy, Ohio

BRAKE TEST LOG

TEST NO. T-1806

Sheet #1 of 3

Date May 2 1968

REQUIREMENTS:

LANDING VELOCITY 140.3 mph
STOP TIME 22.1 sec
STOP DISTANCE 2490 ft

PRESSURE: 190 psi back
psi min.
1000 psi max.

OTHER Cool To 100°

	Stop No.	Log Time	Landing Velocity mph	Brake Press. psi	Stop Time sec	Stop Distance ft	TORQUE Avg. lb ft	TORQUE Peak lb ft	Red Pen TEMPERATURES °F #2 Center Stator Initial	Center Stator Peak	Piston Housing Initial	Piston Housing Peak	#3 Torque Plate Initial	Torque Plate Peak	OTHER PEAK TEMPERATURES °F F.A. 4	B.S. 5	T.W. 6	F.P. 7	Fluid 8	#2 Bezel Blue	P.P. #20	Operator	± Time
Wear in	1	2052	40	300	14.8		1680	1920	78	283	78	92	78	150	100	100	99	95	99	198	131	BH	
	2	2213	60	350	16.7		2520	3510	100	435	82	102	78	223	115	115	120	110	108	418	192	BH	
	3	0025	80	400	22.0		3120	3890	95	882	82	116	88	317	134	127	197	123	120	520	300	KB	
	4	0254	100	450	26.6		3370	4080	95	833	84	126	92	435	166	168	224	150	142	705	435	KB	
			Brake on Speed																				± Tim
	1	0659	140.5	700	23.9		6630	8590	82	1328	80	165	80	732	236	270	372	226	205	1172	702	KB	-1.5
	2	1037	140.5	735	20.5		7980	10,120	81	1165	80	161	80	665	221	246	360	194	199	1152	682	KEB	+0.3
	3	1354	140.9	712	22.4		6910	8730	80	1265	81	169	81	689	241	260	379	198	200	1228	701	KEB	±0.0
	4	1705	140.3	720	22.3				100	1230	91	298	102	855	300	312	428	278	299	1232	858	BH	-0.2
Col Pro 5/6	5 (1)	2130	140.4	720	21.9	2424	6160	7680	80	1263	80	302	80	725	300	325	428	280	308	1495	800	BH	±0.0
	6	0202	140.2	720	21.9	2396	6300	8290	69	1170	79	182	79	576	152	179	270	126	194	1368	695	KB	+0.2
	7	0427	140.3	730	21.5	2368		7550	65	1162	75	122	75	696	248	262	414	250	188	1335	633	KB	+0.9
Hot Park	8	1515	139.7		21.4				65	1250	75	300	75	872	270	308	381	271	301	1450	908	KB	+1.5
	9	1815	140.1	730	22.3				75	1268	77	188	78	680	209	240	339	180	203	1248	723	BH	+1.3
Hot Park 5-7	10	2125	140.4	730	21.4	2347		8170	80	1216	78	176	78	670	211	260	358	190	193	1413	719	BH	+2.0
	11	0652	140.2	730	22.7				62	1342	79	148	79	695	202	256	385	196	172	1135	702	KB	+1.5
	12	1305	140.0	745	21.1	2289.7		6540	65	1212	78	171	78	667	199	241	358	188	170	(2)	701	KEB	+2.4
Hot Park	13	1610	140.5	730	22.7	2462.7			78	1255	80	307	83	841	383	319	378	279	309	1154	925	BH	+1.8
	14	1909	140.3	730	21.1	2250.5			90	1227	80	179	83	701	212	264	384	204	195	1105	700	BH	+2.8
	15	2215	140.1	730	22.9	2492.7	(3) 7500	9200	85	1302	81	170	83	729	211	258	362	203	185	1241	700	BH	+2.0
5-8	16	0113	140.5	730	22.2	2450.1	(3) 4200	5400	72	1234	80	160	80	740	OUT	255	366	200	175	1120	700	KB	+1.9
	17	0427	140.2	730	22.5	2445.8	(3) 4350	5700	70	1287	78	161	78	733	203	234	330	190	182	1252	695	KB	+1.5

REMARKS (1) ON STOP #5 ON COOLING PROFILE FANS WERE OFF TILL BEAD SEAT T/C PEAKED WAS THINKING SAME CONDITIONS WERE IN EFFECT AS HOT PARK CONDITIONS. REASON FOR HIGH TEMPS.
(2) BLUE PEN DIDN'T RECORD ON STOP #12. (3) TORQUE WAS TAKEN FROM PANEL SEE OPRS COMMENT SHEET

EP355

B.F.GOODRICH AEROSPACE & DEFENSE PRODUCTS
Wheel and Brake Plant
Troy, Ohio

BRAKE TEST LOG

TEST NO. T-1906

Sheet #2 of 3
Date May 8, 1968

REQUIREMENTS:

LANDING VELOCITY 140.3 mph
STOP TIME 22.1 sec
STOP DISTANCE 2490 ft

PRESSURE: 140 psi back
psi min.
1000 psi max.

OTHER Cool To 100°

	Stop No.	Log Time	Landing Velocity mph	Brake Press. psi	Stop Time sec	Stop Distance ft	Torque Avg. lb ft	Torque Peak lb ft	Red Pev #2 Center Stator Initial	Center Stator Peak	Piston Housing Initial	Piston Housing Peak	#3 Torque Plate Initial	Torque Plate Peak	False Axle 4	Bead Seat 5	Tube Well 6	Fuse Plug 7	Fluid 8	#2 Rotor Blue	P.Plate #10	Operator	± Sec
																							+1.5
NoT Pulr Sealing R clearance	18	0754	140.2	730	21.6	2321.7	6193 8350	5700	75	1229	80	326	80	778	280	331	376	300	310	1282	879	RB	+2.0
	19	1631	140.7		22.2	2372.2	7200	7200	80	1260	80	159	80	769	219	270	379	211	173	1060	672	RER	+1.9
W&M	20	1325	140.4		21.9	2366.9	7460	9000	90	1210	81	165	81	750	213	252	379	200	189	1210	683	RER	+2.1
5/9	21	0942	140.2	720	22.6	2462.2			70	1334	80	164	80	742	214	272	295	215	190	1402	625	RB	+1.4
	22	0736	140.1	730	22.2	2363.2			88	1353	82	176	82	735	222	222	299	217	196	1728	222	RB	+1.3
SETTING	23	1019	140.5	726	21.6	———		6110	85	1309	81	160	81	891	226	280	329	222	189	1215	841	RER	+1.6
	24	1337	140.5	740	22.7	2477.6		6820	80	1270	80	302	80	933	283	331	260	310	310	1328	860	RER	+1.2
	25	1340	140.2	740	22.7	2474.5	5800	5600	85 ①	1298	82	153	83	700	207	277	309	219	176	①	673	RER	+0.6
Fin clear. 5/10	26	2040	140.4	750	23.0	2525.8			90	1305	83	179	85	727	209	281	324	213	200	1183	709	RER	-0.3
	27	0020	140.1	760	21.6	N.A.		7880	85	1279	82	145	82	692	198	263	294	206	168	1192	662	RB	+0.0
H. Brk	28	0927	140.1	760	21.6	2378.3			80	1296	80	310	80	922	280	333	358	319	324	1137	864	RB	+0.9
	29	0212	140.2	760	22.9	2466.4			80	1225	80	172	80	707	195	256	304	185	120	1202	660	RB	-0.1
W&M	30	0928	140.9	775	22.9	2475.1			80	1292	80	149	80	757	200	248	310	②—	170	1175	669	RER	-0.7
	31	2318	139.4	825	22.8	———	10000	14600	68	1422	80	147	80	737	210	263	301	②—	167	1310	660	RER	-1.6
5-11	32	0500	140.1	825	21.6	2331.9			70	1295	80	150	80	692	205	259	306	②—	168	1400	713	[illegible]	-1.3
Nothing	33 ③	1737	140.2	800	21.9	2376.6			75	1302	82	291	82	927	320	373	314	344	295	1212	890	RER	-1.1
Cont. Pr. ④	34	2155	140.4	800	21.7	2355.1			80	1247	82	139	82	751	278	308	221	278	164	1365	690	RER	-0.7
Cocc. Prob.	35	0846	140.1	800	21.2	———			70	1268	81	150	81	704	214	302	212	262	166	1231	674	[illegible]	+0.0
⑤	36	1851	140.2	800	21.4	2346.0			70	1260	80	154	80	770	220	305	220	279	171	1264	698	RER	+0.5
	37	2208	140.3	800	21.5	2361.2			80	1260	80	141	80	737	220	304	220	279	166	1175	690	RER	+1.5
H.R. 5-13	38	0125	140.2	800	21.2	2366.1			83	1318	80	298	80	935	298	369	315	336	307	1200	904	RB	+1.9
	39	0937	140.1	800	21.5	2293.6			75	1300	80	134	80	777	215	319	216	279	155	1140	685	RB	+2.5
W&M	40	0232	140.1	800	22.9	2420.4			90	1295	80	137	80	774	218	319	220	276	162	1200	700	RB	+2.2

REMARKS ① BLUE PEN DID NOT WORK PROPERLY ON STOP #25 ② T/C NOT WORKING
③ DELAY ON STOP #33 DUE TO DATA ROOM RUNNING TEST ON 120 DYN. ④ DELAY ON STOP #34 TO HELP CHANGE BRAKES ON 120 DYN
⑤ DELAY TO HELP SET UP ANTI SKID ON 120 DATA CONTROL ROOM NO FATIGUE INF ⑥ DELAY DUE TO DATA ROOM RUNNING TEST ON 120 DYN

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B.F.GOODRICH AEROSPACE & DEFENSE PRODUCTS
Wheel and Brake Plant
Troy, Ohio

BRAKE TEST LOG

TEST NO. T-1906

Sheet #3 of 3
Date May 13, 1968

REQUIREMENTS:

LANDING VELOCITY 140.3 mph
STOP TIME 22.1 sec 156.9 o.k.
STOP DISTANCE 2490.0 ft

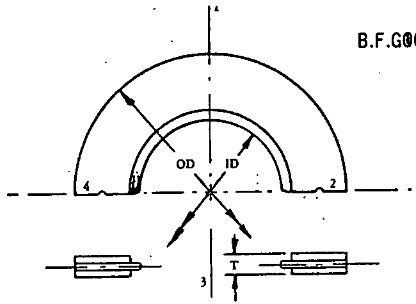
PRESSURE: 140 psi back
psi min.
1000 psi max.

OTHER Cool To 100°

	Stop No.	Log Time	Landing Velocity mph	Brake Press. psi	Stop Time sec	Stop Distance ft	TORQUE Avg. lb ft	TORQUE Peak lb ft	Red Pen TEMPERATURES °F #2 Center Stator Initial	Center Stator Peak	Piston Housing Initial	Piston Housing Peak	#3 Torque Plate Initial	Torque Plate Peak	false axle 4	OTHER PEAK TEMPERATURES °F Bead Seat 5	Tube Well 6	Fuse Plug 7	Fluid 8	#2 Rotor Blue	P. Plate 10	Operator	+2.
Statics	41	2140	140.4	800	22.0	2447.9			75	1385	80	295	80	921	229	319	230	285	270	(1) 1385	783	[illegible]	+2.3
S-14	42	0116	140.2	800	22.6	2468.9			80	1358	82	155	82	820	225	316	220	285	128	(2)	728	RB	+1.8
V.Park	43	0441	140.2	800	22.7	2105.1			80	1360	80	275	80	998	225	349	288	315	280	(2)	918	RB	+1.2
	44	0552	140.6	820	22.8	1694.9			77	1345	81	160	81	824	231	329	232	282	182	1182	692	[illegible]	+0.3
displ.	45	1122	140.2	850	22.3	1601.0			82	1311	82	161	81	782	217	329	219	198	185	1187	739	[illegible]	+0.3
	46	1811	155.1	770	24.5	3045.	5400	6190	78	(3)	78	202	75	945	182	261	301	183	230	(2)	794	CW	
	47	2137	155.5	790	25.4	3225. (4)			75	1512	120	266	120	1053	232	326	360	241	268	(2)	890	CW	
	48	2341	156.3	820	25.4	3242.			92	1558	117	370	120	1056	271	466	528	420	380	1545	872	CW	
	49	0442	1520	850	26.7	3510		[illegible]	75	1568	116	365	116	1120	391	471	529	438	385	[illegible]	929	JW	
	50	0739	156.8	860	26.6	3584			75	1545	110	300	110	1100	214	—	—	—	280	1412	954	JW	
51	RTO1	1623	60.1	600	14.4	682.			80	381	100	118	105	310	122	144	149	136	122	↑	310	CW	
52	RTO2	1628	170.7	1000	42.[illegible]	5374.			349	2230	118	390	281	1601	521	590	669	486	400	568 2880	1409	CW	
						1634	FUSE PLUGS BLEW																
						1634	FUSE PLUG BLEW																

REMARKS (1) T/C ON #2 ROTOR (BLUE PEN) STOPPED WORKING DURING HST. {TEST DELAYED FROM 1725 P.M. TO 1811 P.M. DUE TO DATA ROOM
(2) Blue Pen still not working Properly (3) RED PEN NOT WORKING PROPERLY
(4) TORQUE NOT GIVEN BY DATA ROOM

FP355



B.F.GOODRICH AEROSPACE & DEFENSE PRODUCTS
Wheel and Brake Plant
Troy, Ohio

WEAR DATA

Disk ✓ _ Lining

TEST NO. T-1906
Sheet 1 OF

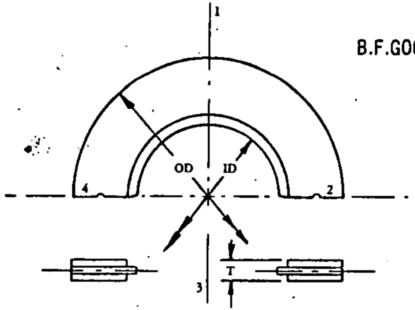
NOMENCLATURE

Disk Assy No. 134-44
Carrier No. —
Segment No. 133-302
Friction Material STEEL

Carrier & Lining Assy No. /
Carrier No.
Lining No.
Friction Material

BRAKE LOCATION NO.	STOP COMPLETED	WT. LBS.	OD INS.	ID INS.	THICKNESS Position 1 in.	2 in.	3 in.	4 in.	Avg. in.	WEAR Total ins.	Per Stop Per Surf. ins.	REMARKS BLUE PEN !?! YES!!!!
1	New	10.6	".893/411	7.105/125	.503	.503	.503	.503				
	10	10.6	.960/.896	.168/.095	.504	.502	.499	.499				
	20	10.4	.950/.905	.120/.165	.503	.502	.501	.503				
	30	10.3	.803-.769	.240-.240	.496	.495	.490	.490				
	40	10.2	746-800	255-400	489	489	488	487				
	45	10.1	12000/11.920	160/103	488	486	487	509				
2	New	10.6	"990/930	7.150/.045	.504	.504	.504	.504				
	10	10.56	981/978	140/112	.503	.503	.500	.505				
	20	10.4	.970/.965	.146/.150	.497	.500	.495	.493				
	30	10.3	.780-.785	.206-.264	.475	.474	.473	.492				
	40	10.2	776-761	260-220	490	490	488	489				
	45	10.2	868/956	032/300	511	511	510	510				
3	New	10.6	"908/935	7.105/.121	.504	.504	.504	.504				
	10	10.55	964/941	".140/.136	.498	.498	.499	.499				
	20	10.4	.970/940	.125/.150	.498	.502	.495	.494				
	30	10.3	.850-.969	.142-.123	.486	.484	.486	.485				
	40	10.2	900-915	148-120	486	485	484	485				
	45	10.1	928/952	088/147	507	507	506	506				
4	New	10.6	"997/903	7.124/.096	.504	.504	.503	.503				
	10	10.55	.975/.900	.190/.095	.502	.501	.501	.502	~~.48~~			
	20	10.4	.950/965	.170/115	.498	.497	.491	.498				
	30	10.25	.724-.840	.211-.210	.494	.492	.491	.493				
	40	10.1	763-830	150-187	495	490	490	491				
	45	10.1	930/925	100/143	504	504	503	504				

EP215



B.F.GOODRICH AEROSPACE & DEFENSE PRODUCTS
Wheel and Brake Plant
Troy, Ohio

WEAR DATA

Disk __ ✓ Lining

TEST NO. T-1906
Sheet 2 of

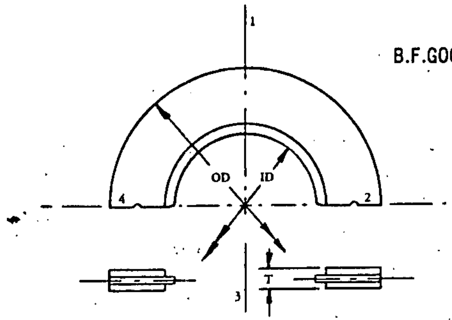
NOMENCLATURE

Disk Assy No. ______
Carrier No. ______
Segment No. ______
Friction Material ______

Carrier & Lining Assy No. 244-270 X
Carrier No. ~~[illegible]~~ 261-268
Lining No. 5093A
Friction Material SINTERED

BRAKE LOCATION NO.	STOP COMPLETED	WT. LBS.	OD INS. 11"	ID INS. 7"	THICKNESS Position 1 in.	2 in.	3 in.	4 in.	Avg. in.	WEAR Total ins.	Per Stop Per Surf. ins.	REMARKS
1	NEW	7.0	.861-.859	.078/.065	.444	.444	.444	.445				
	10	6.85	.850-.844	.050/.050	.402	.417	.419	.405				
	20	6.5	.819/.825	.024/.012	.391	.408	.405	.406				
2	NEW	7.0	.860-.855	.082/.081	.445	.446	.445	.445				
	10	6.9	.845-.845	.060/.036	.434	.430	.419	.425				
	20	6.6	.830/.820	.035/.030	.421	.413	.363	.370				
3	NEW	7.0	.851-.853	.079/.070	.445	.445	.445	.445				
	10	6.9	.850-.848	.068/.065	.416	.407	.426	.423				
	20	6.6	.827/.836	.040/.040	.392	.367	.391	.409				
~~[illegible]~~ PP	USED	8.9	.893/.895	.004/.007	.544	.542	.540	.543				FROM T-1904 PEAK TORQUE
	10	9.0	.890/.890	.040/.000	.540	.525	.505	.548				
	20	8.7	.898/.900	.062/.060	.528	.501	.464	.494				LINING CHIPPED OFF 2 SEGS. 1 RUN THD [illegible]
TP	USED	17.1										FROM T-1904 PEAK TORQUE
	10	17.1										
	20	16.9										

EP215



B.F.GOODRICH AEROSPACE & DEFENSE PRODUCTS
Wheel and Brake Plant
Troy, Ohio

WEAR DATA

Disk _ ✓Lining

TEST NO. T-1906
Sheet 3 oF

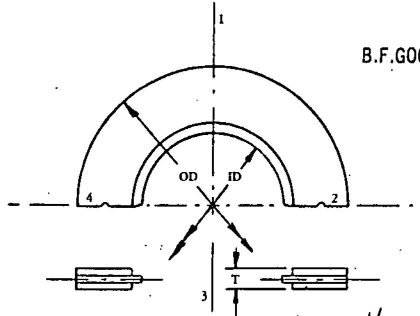
NOMENCLATURE

Disk Assy No. _____
Carrier No. _____
Segment No. _____
Friction Material _____

Carrier & Lining Assy No. 244-270x
Carrier No. 261-268
Lining No. 5043-A
Friction Material Sintered

BRAKE LOCATION NO.	STOP COMPLETED	WT. LBS.	OD INS. 11"	ID INS. 7"	THICKNESS Position 1 in.	2 in.	3 in.	4 in.	Avg. in.	WEAR Total ins.	Per Stop Per Surf. ins.	REMARKS
1	30	6.1	.782-.780	6.962-.932	.346	.343	.392	.394				
	40	5.5	760-730	909-924	292	367	306	278				
	45	5.4	705/714	6908/884	283	326	341	383				
	50	5.1	660/750	6406/6461	295	266	257	296				
2	30	6.4	.815-.812	.012-.6993	.405	.397	.340	.372				
	40	5.7	752-768	6960-964	375	376	285	363				
	45	5.5	725/728	942/919	356	265	266	360				
	50	5.2	690/710	6.450/6.491	329	312	255	258				
3	30	6.2	.830-.815	.870-.860	.383	.350	.376	.402				
	40	5.6	734-765	6932-921	356	255	355	368				
	45	5.5	695/685	6909/842	352	251	261	359				
	50	5.1	675/665	6.460/455	324	258	255	317				
P.P.	30	8.6	.889-.887	.005-.005	.490	.445	.482	.502				
	40	8.4	892-890	064-064	526	464	462	510				
	45	8.3	900/884	032/045	510	455	452	476				
	50	8.1	875/872	6654/6680	431	433	482	484				
T.P.	30	16.7										
	40	16.5										
	45	16.4										
	50	16.2										
Spacer	50	5.0			261	262	261	261				

EP215



B.F.GOODRICH AEROSPACE & DEFENSE PRODUCTS
Wheel and Brake Plant
Troy, Ohio

WEAR DATA

Disk ✓ _ Lining

TEST NO. T-1906
Sheet 4 oF

NOMENCLATURE

Disk Assy No. 133-44
Carrier No. —
Segment No. 133-702
Friction Material STEEL

Carrier & Lining Assy No. /
Carrier No.
Lining No.
Friction Material

OK

BRAKE LOCATION NO.	STOP COMPLETED	WT. LBS.	OD INS.	ID INS.	THICKNESS					WEAR		REMARKS
					Position				Avg. in.	Total ins.	Per Stop Per Surf. ins.	
					1	2	3	4				
			11"	7"	in.	in.	in.	in.				
1	50	10.1	998-920	160-103	487	488	491	489				
2	50	10.1	867-958	031-298	484	485	483	483				
3	50	10.1	926-460	085-148	480	481	481	479				
4	50	10.1	949-927	101-145	489	489	489	488				

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34-919 O - 70 - 14

B.F.GOODRICH AEROSPACE & DEFENSE PRODUCTS
Wheel and Brake Plant
Troy, Ohio

STATIC TORQUE

TEST NO: T-1906

Sheet 1

Brake Assembly No. 2-1162-3

Lining No. 5043A

Lining Material SINTERED

Disk No. 134-44

Disk Material STEEL

Date	After Stop No.	Amb. Temp. °F	Brake Temperature Hot °F	Brake Temperature Cold °F	Brake Pressure Hot psi	Brake Pressure Cold psi	Static Torque Hot lb ft	Static Torque Cold lb ft	REMARKS
5-3-68	4	82	1200		1000		10,000 1ST TRY.		THESE TORQUES TAKEN FROM PANEL.
							7800 2ND "		
5-3-68	4	80		95		1000		18,000	" " " " "
5-7-68	23	80	1200		1000		11,000		PANEL READING
5-9-68	23	80		110		1000		16,800	PANEL READING
5/13/68	41	80	1200	108	1000	1000	10,300	(1) 11,990	PANEL READING (1) DATA Room Reading

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B.F.GOODRICH AEROSPACE & DEFENSE PRODUCTS
Wheel and Brake Plant
Troy, Ohio

STATIC TORQUE

TEST NO. T-1906

Sheet 1 OF 1

Brake Assembly No. 2-1162-3

Lining No. 244-270

Lining Material 5043

Disk No. 134-44

Disk Material STEEL

Date	After Stop No.	Amb. Temp. °F	Brake Temperature		Brake Pressure		Static Torque		REMARKS
			Hot °F	Cold °F	Hot psi	Cold psi	Hot lb ft	Cold lb ft	
5-3-68	4	82	1200		1000		6000	1ST TRY	THESE TORQUES TAKEN FROM PANEL X .6
							4680	2ND TRY	
5-3-68	4	80		95		1000	~~10,800~~	10,800	" " " " "
5-9-68	23	80	1200		1000		6600		PANEL READING X .6 FOR OFFSET
5-9-68	23	80		100		1000		10080	

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B.F.GOODRICH AEROSPACE & DEFENSE PRODUCTS
Wheel and Brake Plant
Troy, Ohio

TEST NO. T-1867

Sheet 1 of 7

DATE	SIGNATURE	SPECIAL TEST REQUIREMENTS AND PROCEDURES
4/3/68	R. Glor.	TEST SET-UP INSTRUCTIONS: BLOCK R.R. @ 11.0". FOR WEAR-IN STOPS, HOOK UP OSCILLOGRAPH T'COUPLES TO 84" DYN TWO PEN RECORDER.
4/3/68	R. Glor.	PRIOR TO EACH STOP, THE OPERATOR WILL CHECK TIRE INFLATION PRESSURE AND MAINTAIN 260 PSI ± 2 PSI NITROGEN.
4/3/68	R. Glor	PRIOR TO EACH STOP, THE OPERATOR WILL RECORD ON FORM EP65 (OPERATOR'S COMMENT SHEET) ANY AND ALL CONDITIONS, OCCURRENCES, PHENOMENON, ETC. THAT OCCURRED PRIOR TO THE STOP. IN ESSENCE, THE OPERATOR WILL MAINTAIN A LOG OR HISTORY OF THE TEST.
4/3/68	R. Glor.	EFFECTIVE WITH STOP #1, REQ'D OSCILLOGRAPH T'COUPLES WILL BE HOOKED UP TO THE OSCILLOGRAPH (AND NOT THE 84" DYN TWO-PEN RECORDER).
4/3/68	R. Glor.	AFTER THE #4 WEAR-IN STOP & PRIOR TO STOP #1, PULL THE WHEEL FROM THE AXLE AND HOLD FOR ENGR INSPECTION ON 04 APR A.M.
4/4/68	R. Glor.	TO OBTAIN TRUE TORQUE MULTIPLY PANEL TORQUE TIMES .6

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B.F.GOODRICH AEROSPAC. & DEFENSE PRODUCTS
Wheel and Brake Plant
Troy, Ohio

TEST NO. T-1867

Sheet 2 of 7

DATE	SIGNATURE	SPECIAL TEST REQUIREMENTS AND PROCEDURES
4/4/68	R. Glor.	FOR COOLING OF THE BRAKE, PLACE ONE MOBILE FAN NEAR DOOR
		AT ENTRANCE TO CAGE OF LIFT ARM AND APPROXIMATELY AT A
		45° ANGLE TO THE VERTICAL PLANE OF THE TIRE. (PER S. LAWSON)
4/4/68	R. Glor.	AFTER WEAR-IN #4 INSTALL THE AXIAL ACCELEROMETER.
4/4/68	S.J. Lawson	apply temperature sensitive paint to brake: Code is
		a) 915-0935 Yellow → GREEN 1184°F
		GREEN → OLIVE 1544°F
		OLIVE → BLACK 1787°F
		b) 915-0932 Yellow → ORANGE 788°F
		ORANGE → GRAY 1292°F
		GRAY → BROWN 1508°F
		Record the results after the stop in operators comment
		sheets.
4/4/68	R. Glor.	PRIOR TO STOP #1 & EACH SUCCESSIVE STOP THEREAFTER: USE A STIFF
		WIRE BRUSH AND BRUSH THE TREAD OF THE TIRE TO REMOVE ALL
		EXCESS RUBBER WADS & ROLLS. (PER R. Sink)

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B.F.GOODRICH AEROSPAC. . DEFENSE PRODUCTS
Wheel and Brake Plant
Troy, Ohio

TEST NO. T-1867

Sheet 3 of 7

DATE	SIGNATURE	SPECIAL TEST REQUIREMENTS AND PROCEDURES
4/4/68	R. Glon.	RUN OSCILLOGRAPH ON BUSTY STOP (& ON HOT & COLD STATICS).
		DURING HOT PARKS & COOLING PROFILES, RUN OSCILLOGRAPH LONG
		ENOUGH TO OBTAIN PEAK TEMPERATURES, THEN TURN IT OFF.
4/4/68	S.J. Lawson	Place regular thermocouples in rotors on stop # 2
4/5/68	R. Glon.	RELOCATE COOLING FAN SO THAT IT BLOWS DIRECTLY INTO
		THE OUTBOARD SIDE OF THE WHEEL & INTO THE BRAKE (PER R. SINK)
4/5/68	R. Glon.	PRIOR TO STOP #6, CHANGE TIRE & REPLACE ROTOR T'COUPLES WITH
		2 NEW ST. STEEL T'COUPLES.
4/6/68	S.J. Lawson	Change tire ~~and~~ before stop #15 and stator thermocouples on
		stop #20.
4/6/68	S.J. Lawson	Decrease pressure at 18 MPH, have zero pressure
		and constant velocity by 10 MPH. (See example)
		Constant velocity can be between 15 MPH and
		10 MPH. (Count stop time to 10 MPH)
		"Change tires when tread seperates
		from case."

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B.F.GOODRICH AEROSPAC. . DEFENSE PRODUCTS
Wheel and Brake Plant
Troy, Ohio

TEST NO. T-1867

Sheet 4 of 7

DATE	SIGNATURE	SPECIAL TEST REQUIREMENTS AND PROCEDURES
4/7/68 1235 hrs.	S. J. Lawson	After stop #20 Weight & Measure heat stack and get total Brake Weight.
4/8/68	R. Glon.	PRIOR TO STOP #27, ~~CHANGE~~ REPLACE THE #2 ROTOR ST. STEEL T'COUPLE.
4/8/68	R. Glon.	EFFECTIVE STOP #14 & UP: AT EACH WHEEL REMOVAL, SPRAY MOLYBDENUM DI-SULFIDE ON INSERTS IN WHEEL. (PER R. SINK)
4/8/68	R. Glon. X	AT STOP #20 TEAR DOWN OF BRAKE REVERSE POSITION OF HEAT SINK ELEMENTS DURING RE-ASSEMBLY, I.E., #1 ROTOR IN #4 POSITION ETC. (PER R. SINK).
4/8/68	R. Glon.	CHANGE TIRE AFTER STOP #27.

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B.F.GOODRICH AEROSPAC. . DEFENSE PRODUCTS
Wheel and Brake Plant
Troy, Ohio

TEST NO. T-1567

Sheet 5 of 7

DATE	SIGNATURE	SPECIAL TEST REQUIREMENTS AND PROCEDURES
4/8/68	R. Glon	At stop #30 brake tear down, perform weigh & measure on
		heat sink elements.
4/9/68	S.J. Lawson	Count total stop time from 151 MPH to 10 MPH
4/11/68	S.J. Lawson	Use pressure of 1000 psi for stop #46.
4/11/68	R. Glon.	After stop #47, pull brake for engr. inspection
4/11/68	R. Glon.	At stop #47 tear down of brake; send the 3
		stators to the tool room & have the I.D.'s opened
		up .125" per the direction of R.L. Sink.
4/11/68	R. Glon.	Use 1000 PSI brake pressure for stops 48, 49 & 50 per
		direction of R. Sink.
4/11/68	R. Glon.	Replace st. stator T'couples with standard T'couples for
		stop 48, 49 & 50. Replace T'couples as req'd for
		remainder of test.
4/11/68	R. Glon.	Effective stops 49 & 50; per R. Sink, decrease cooling time to
		what ever is req'd to cool brake down to 100°F b/t stops.
4/11/68	R. Glon.	Change tire prior to RTO.

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B.F.GOODRICH AEROSPACE [illegible] DEFENSE PRODUCTS
Wheel and Brake Plant
Troy, Ohio

TEST NO. T-1867

Sheet 6 OF 7

DATE	SIGNATURE	SPECIAL TEST REQUIREMENTS AND PROCEDURES
4/11/68 1925	S. J. Lawson	The worn Brake RTO2 shall be run to the
		following conditions. KE = 16.005x10^{6} FT-LBS, IE =
		19311. lbm., V = 161.80 MPH., Stop Time = 23.73 Sec.
		Delete weight and measure after stop. 50
4/11/68	R. Glor.	PRIOR TO R.T.O., PULL BRAKE FROM ARM AND REWORK STATOR
		LUGS AS REQUIRED TO ALLOW LUGS TO MOVE FREELY IN TORQUE TUBE SLOTS.

EP64

B.F.GOODRICH AEROSPAC. DEFENSE PRODUCTS
Wheel and Brake Plant
Troy, Ohio

TEST NO. T-1867 (R.T.O)

DATE	SIGNATURE	SPECIAL TEST REQUIREMENTS AND PROCEDURES
4/17/68	R. Glon.	PRIOR TO PERFORMING THE SMALL & LARGE R.T.O. ON THE
		NEW BRAKE CONFIGURATION, RUN WEAR-INS AT THE FOLLOWING:
		VELOCITY BRAKE PRESSURE
		50 350
		80 450
		100 500
		USE 2 FANS DURING WEAR-IN STOPS AND ONE FAN DURING
		& AFTER SMALL R.T.O. & ONE FAN DURING LARGE R.T.O. ONLY.
		TURN OFF FAN AT END OF LARGE R.T.O.
4/17/68	R. Glon.	COOL TO 100°F B/T WEAR-IN STOPS
4/17/68	R. Glon.	USE 700 PSI FOR LOW ENERGY R.T.O. & 1000 PSI FOR HIGH ENERGY R.T.O

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B.F.GOODRICH AEROSPACE & DEFENSE PRODUCTS
Wheel and Brake Plant
Troy, Ohio

TEST NO. T-1867

OPERATOR'S COMMENTS

Sheet No. 1 OF 9

DATE	OPERATOR	REFERENCE	COMMENTS
4-4-68	Jcw	WI #1	ROAD WHEEL WAS CLEANED BEFORE ~~...~~ WEAR IN #1. TANGENTIAL FORCE FOR ROLLING WHEEL WAS 10# DIMINISHING TO 5#. TIRE WAS REINFLATED FROM 25? TO 260 PSI BEFORE STOP (TIRE HAD SAT APPROX 1/2 HR SINCE FIRST INFLATION TO 260 PSI), NO SIGNIFICANT ~~...~~ TROUBLE SHOWN DURING STOP.
4-4-68	Jcw	WI #2	ROAD WHEEL WAS CLEANED BEFORE WEAR IN # 2. TANGENTIAL FORCE FOR ROLLING WHEEL WAS 10# DIMINISHING TO 5#. TIRE WAS REINFLATED FROM 245 TO 260 PSI BEFORE STOP. HAVING TROUBLE WITH 84" DYN TEMPERATURE - TAKING.
4-4-68	Jcw	WI #3	ROAD WHEEL WAS CLEANED BEFORE WEAR-IN #3. TANGENTIAL FORCE WAS AS BEFORE (#1 & #2). TIRE DID NOT NEED AIR. STILL HAVING TROUBLE WITH 84" DYN TEMP-TAKING.
4-4-68	JDS	WI #4	ROAD WHEEL CLEANED BEFORE STOP. TIRE INFLATION O.K. STOP DELAYED BECAUSE INSTRUMENTATION WAS TROUBLE SHOOTING T'COUPLE PROBLEMS ON 84" DYN TWO PEN RECORDER. RAN STOP SATISFACTORILY BUT 84" DYN 2-PEN RECORDER T'COUPLES DIDN'T WORK PROPERLY. CHECKED R.R. PRIOR TO STOP - GOT 11.4 INCHES; ACCEPTABLE PER R. GLOCK.
4-4-68	JDS (RH)	STOP # 1	CLEANED ROADWHEEL & TIRE. HOOKED UP AXIAL ACCELEROMETER & 2 T'COUPLES TO OSCILLOGRAPH. REPAIRED & CHECKED OUT STAINLESS STEEL T'COUPLES. PAINTED TEMP SENSITIVE PAINT ON BRAKE. BRAKE CLEARANCE BEFORE STOP WAS .072 INCHES BETWEEN P.P. & #1 ROTOR. DISPLACEMENT WITH 1000 PSI IN BRAKE WAS 30 ML. AT REQUEST OF R. SINK SPRAYED MOLY DISULFIDE ON 16-44 LINKS OF THE DISK ASSEMBLIES. INFLATED TIRE (WAS 250 PSI) TO 260 PSI. TIRE HAS SLIT ON INSIDE SIDEWALL - O.K. TO RUN PER S. LARSEN.
4-4-68	CW	DURING, BEFORE & AFTER STOP #1	DURING STOP #1 BLUE PEN (ROTOR #2) DIDNT WORK. BEFORE STOP #1 TEST WHEEL WAS LANDED APPROX. 20 mph TAXI TO CHECK OUT OSC.
4-4-68	CW.	BEFORE STOP #2	ROAD WHEEL WAS CLEANED - TIRE WAS CLEANED - BRAKE WAS CLEANED OUT WITH FORCED AIR. TWO ROTORS WITH (con)

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B.F.GOODRICH AEROSPACE & DEFENSE PRODUCTS
Wheel and Brake Plant
Troy, Ohio

TEST NO. T-1867

OPERATOR'S COMMENTS

DATE	OPERATOR	REFERENCE	COMMENTS
4-4-68	CW	(CON FROM PAGE ONE)	STAINLESS THERMOCOUPLES WAS REPLACED WITH REGULAR THERMOCOUPLES. - THERMO PAINT WAS CHECK FOR ANY CHANGE - TIRE PSI WAS 247 REINFLATED TO 260 PSI.
4-4-68	CW	BEFORE STOP #3	ROAD WHEEL WAS CLEANED - TIRE WAS CLEANED — NOTE: ONE HOUR AFTER STOP (WITH WHEEL PULLED) BRAKE WAS COOL ENOUGH TO LAY MY HAND ON. NOTE: ALL LINING CARRIERS APPEAR TO HAVE A BONDING PROBLEM WITH THE LINING MATERIAL, NOTICED WHAT APPEAR TO BE HAIRLINE CRACKS B/T CARRIER & MATERIAL. TIRE INFLATION PSI WAS 250 REINFLATED TO 260 PSI & PUT VALVE CAP ON CORE. INSTRUMENTATION WORKED ON #1 STATOR THERMOCOUPLE (STAINLESS STEEL) BRAKE PSI WAS SET BEFORE THE STOP, THEN THE INSTRUMENTATION MAN CALIBRATED PRESSURE ON CHART AND I RECHECKED BRAKE PRESSURE AND PRESSURE WAS UP 150 PSI MORE. I THEN RESET PRESSURE TO 710 PSI. I RAN THE STOP WHICH WAS OVER ON STOP TIME AND THE TORQUE DIDN'T COME UP AS FAR AS I THOUGHT IT SHOULD.
4-5-68	Jw	STOP #4	BEFORE STOP: ROAD WHEEL WAS CLEANED; WHEEL WAS TAKEN OFF TO "BLOW OUT" BRAKE; ~~[illegible]~~ TANG. FORCE WAS MEASURED TO BE 10#; WHEEL ROTATED VERY FREELY; TIRE WAS SCRABBED CLEAN; TIRE WAS REINFLATED FROM 250 PSI TO 262 PSI. AFTER STOP: FANS WERE TURNED OFF FOR 3 MINUTES TO PUT BELT OVER WHEEL TO RUN A HOT STATIC. FALSE AXLE THERMO DID NOT FUNCTION PROPERLY. ~~[illegible]~~ TIRE SLIPPED WHILE PULLING HOT STATIC, BUT ACCORDING TO THE CHART, THE BRAKE MADE THE REQUIRED TORQUE.
4-5-68	Jw	STOP #5	BEFORE STOP: COLD STATICS WERE RUN WITHOUT ~~[illegible]~~ TIRE SLIPPAGE; ROAD WHEEL WAS CLEANED; BRAKE WAS "BLOWN OUT" AFTER WHEEL WAS TAKEN OFF; FALSE AXLE THERMO WAS FIXED; TIRE PRESSURE WAS 258 PSI SO NINE WAS ADDED. AFTER STOP: BRAKE WAS PLACED ON HOT PARK SPECS AFTER STOP; NO FANS WERE ON AFTER STOP AND THEY WERE TURNED ON AT 0646 AM AFTER THE TEMPERATURES WERE PEAKED; THE THERMO CHARTS WERE LEFT ON TO OBTAIN A COOLING PROFILE; THE CHARTS WERE TURNED OFF AT 07:00 (W/OUT) & 07:11 (W/THERMOCOUPLE). IN ADDITION, PRESSURE WAS TAKEN OFF OF BRAKE AT 06:46 AM AFTER THE TEMPERATURES HAD PEAKED; ALSO, BEFORE STOP, WHEEL WAS ROTATED FREELY WITH THE TANG. FORCE BEING MEASURED AT 10# DIMINISHING TO 7#. ~~AFTER STOP: EVERYTHING WORKED PROPERLY EXCEPT THE~~

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B.F.GOODRICH AEROSPACE & DEFENSE PRODUCTS
Wheel and Brake Plant
Troy, Ohio

TEST NO. 1867

OPERATOR'S COMMENTS

Sheet No. 3 of 9

DATE	OPERATOR	REFERENCE	COMMENTS
4-5-68	JDS	Stop #6	Road wheel cleaned, Tire changed, brake cleaned out, T.C. replaced with stainless steel T.C. on 1+2 Rotors. changed fan To blow streight into wheel.
4-5-68	JDS	Stop #7	Road wheel cleaned, brake cleaned out, Tire cleaned off. re inflate Tire 260 P.S.I.
4-5-68	JDS	Stop #8	Road Wheel Cleaned, brake Cleaned, inflation Checked (260) P.S.I. Cleaned little rubber balls off tire.
4-5-68	CW	BEFORE STOP #9	CLEANED ROAD WHEEL - CLEANED TIRE - BRAKE CLEANED OUT WITH FORCED AIR. TIRE PSI 260 PSI — #2 ROTOR (SS) THERMOCOUPLE SHORTED OUT DURING STOP)
4-5-68	CW	BRAKE CLEARANCE	AFTER STOP #9 WAS .049 TOP .049 BOTTOM.
4-5-68	CW.	BEFORE STOP #10	CLEANED ROAD WHEEL - CLEANED TIRE - BRAKE CLEANED OUT WITH FORCED AIR. TIRE PSI WAS 259 PSI.
4-5-68	CW.	FLUID DISPLACEMENT	AFTER STOP #10 W/1000 PSI WAS. 43 ML.
4-5-68	CW.	AFTER STOP #10	THE BRAKE WAS REMOVED FROM THE AXLE. THE BRAKE WAS THEN TAKEN APART. ALL SLOTS ON THE STATORS WAS CLEANED OUT AND THE SLOTS ON THE I.D. OF THE ROTORS WAS CLEANED OUT. THEN A VISUAL INSPECTION WAS MADE AT THIS TIME. THERE WAS MINOR HAIR LINE CRACKS IN THE LINING AND HOT SPOTS ON THE ROTORS. THE BRAKE WAS THEN PUT BACK TOGETHER.
4-5-68	CW & JW	BEFORE STOP #11	TIRE WAS CLEANED. ROAD WHEEL WAS CLEANED. TIRE WAS INFLATED FROM 252 TO 260 PSI. WHEEL COULD ROTATE FREELY WITH TANGENTIAL FORCE OF 10 TO 7 lbs. NO ASSUMPTIONS WILL BE MADE. THERE WAS A DELAY BEFORE THE STOP FOR OSCILLOGRAPH ~~HEAT~~ CALIBRATION. THERE WAS NEAR DELAY WHEN THE ROAD WHEEL WAS STARTED UP AND IT WAS DISCOVERED TO BE ROTATING FOR THE RIGHT SIDE FOR SOME UNKNOWN REASON (THE SWITCH WAS ON RIGHT AUTO, BUT WHY?) (TO CLEAN THE ROAD WHEEL—CW)
4-6-68	Jaw	Stop #11	CENTER STATOR THERMO DID NOT WORK RIGHT. HOWEVER, IT DID CHECK OK BEFORE THE STOP.
4-6-68	Jaw	Stop #12	BEFORE STOP: THERMOS WERE RECHECK AND WERE MADE TO WORK. ROAD WHEEL WAS CLEANED OF SUPERFLOUS MATTER. THE TIRE WAS CLEANED OF EXTRANEOUS RUBBER MATERIAL. WHEEL WAS TAKEN OFF TO "BLOW OUT" LINING DUST. TIRE INFLATION WAS OK. THE WHEEL WOULD ROLL FREELY. AFTER STOP: EVERYTHING WORKED OK WITH EXCEPTION OF THE 3-POINT RECORDING OF THE TORQUE PLATE.

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B.F.GOODRICH AEROSPACE & DEFENSE PRODUCTS
Wheel and Brake Plant
Troy, Ohio

TEST NO. T-1867

OPERATOR'S COMMENTS

Sheet No. 4 OF 9

DATE	OPERATOR	REFERENCE	COMMENTS
4-6-68	Jaw	CONT'D STOP 12	(NOS. 1,3,4,5). NO. 5 GAVE A HIGHER TEMPERATURE (RELATIVE TO OTHER STBS) WHILE NO. 1 & NO. 3 GAVE
			LOWER TEMPERATURES
4-6-68	Jaw	AFTER STOP #10	TIRE WAS NOT CHANGED AFTER STOP #10 (IT WAS, AFTER STOP #6). NOTHING WAS NOT SAID TO
			CHANGE THE TIRE, WHEN 3RD SHIFT CAME IN. 2ND SHIFT HELPED 3RD SHIFT WITH PUTTING THE
			BRAKE AND TIRE BACK ON. MR BLAIR SAID IT WAS READY TO GO. ~~[illegible]~~
			~~[illegible]~~
4-6-68	JDS	Before Stop #12	Wheel was removed brake cleaned, Rotor T.C. repaired, Road Wheel
			Cleaned, Tire cleaned.
4-6-68	WHW	BEFORE Stop #13	#1 STATOR GALVO BAD REPLACED GALVO & RECALIBRATED. T/C ON
			BEGINING OF TRACE FOR STOP #13
4-6-68	JDS	Before Stop #14	Wheel removed & brake cleaned. T.C fixed Road wheel cleaned
			Tire cleaned.
4-6-68	JDS	Before stop #15	Road wheel cleaned, TC fixed B.S. T.C. Replaced Tire changed
4-6-68	CW.	BEFORE STOP #16	ROAD WHEEL CLEANED. TIRE CLEAN. GREASE SEAL BAD (TORN LOOSE AT [illegible])
			TIRE PSI WAS 230 PSI REINFLATED TO 260. PSI. GREASE SEAL REPLACED.
4-6-68	CW	BEFORE STOP #17	ROAD WHEEL CLEANED - TEST WHEEL CLEANED. BRAKE WAS CLEANED OUT WITH
			FORCED AIR. TIRE PSI WAS 250 PSI REINFLATED TO 260 PSI
4-6-68	CW	BEFORE STOP #18	ROAD WHEEL WAS CLEANED - TEST WHEEL WAS CLEANED. BRAKE WAS CLEANED OUT
			WITH FORCED AIR. AT THIS TIME SPECIAL ATTENTION WAS PAID TO #1 LINING
			CARRIER. NO NOTICABLE LINING MISSING EXCEPT AROUND OD SLOTS.
			THE LINING ON THE PISTON HOUSING SIDE HAD EXCESIVE WEAR COMPARED
			TO THE REST OF THE LINING. AFTER HAVING THE BRAKE READY AND
			WHEEL BACK ON. SS THERMOCOUPLE ON #1 ROTOR WAS FOUND TO
			BE BAD. THE WHEEL WAS REMOVED ~~[illegible]~~ AND THE SS THERMOCOUPLE
			WAS REPLACED. TIRE PSI WAS 254 REINFLATED TO 260 PSI
4-7-68	JDS	Clearance	Clearance was .153 After stop #18
4-7-68	JDS	Before stop #19	Tire cleaned, wheel cleaned, Brake Cleaned 10 PSI Added (260)
4-7-68	JDS	Before Stop #20	Tire cleaned, wheel cleaned, Road wheel cleaned Brake cleaned
4-7-68	JDS	Before Stop #21	Tire changed wheel cleaned, Road Wheel cleaned brake taken apart
			for W+M slots cleaned IN Brake D wear in ran at 100 MPH + 300 PSI

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B.F.GOODRICH AEROSPACE & DEFENSE PRODUCTS
Wheel and Brake Plant
Troy, Ohio

TEST NO. T-1867

OPERATOR'S COMMENTS

Sheet No. 5 of 9

DATE	OPERATOR	REFERENCE	COMMENTS
4-7-68	C.W.	WI Step #5	WAS RAN AT 100mph & 300 PSI. NEW THERMOCOUPLES WAS PUT IN THE BRAKE. TIRE had 260 PSI FOR STEP.
4-7-68	CW	BEFORE STEP #21	ROAD WHEEL WAS CLEANED TEST WHEEL WAS CLEANED BRAKE WAS CLEANED OUT WITH FORCED AIR TIRE PRESSURE WAS 235 REINFLATED TO 260 PSI. Heat SINK was Reversed PER R.L. SINK'S INSTRUCTIONS
4-7-68	CW	BEFORE STEP #22	ROAD WHEEL WAS CLEANED - TEST WHEEL WAS CLEANED - BRAKE WAS CLEANED OUT WITH FORCED AIR TIRE PRESSURE WAS 250 & REINFLATED TO 260 PSI
4-8-68	Jaw	STOP #23	BEFORE STOP; WHEELS (ROAD & TEST (TIRE)) WERE CLEANENED; TIRE PRESSURE WAS OK AT 258 PSI; WHEEL WAS REMOVED TO "BLOW OUT" BRAKE; WHEEL COULD BE ROTATED FREELY WITH A TANG FORCE OF 10 TO 5 lbs. AFTER STOP: FANS WERE OFF 5 MINUTES TO PLACE BELT OVER WHEEL FOR HOT STATICS. HOT STATICS WERE RUN WITH THE RESULTS SHOWN ON EP68. TIRE DID SLIP OVER WHEEL A LITTLE. COLD STATICS WERE PULLED ALSO. EVIDENCE THAT TIRE SLIPPED A LITTLE WAS THE MOVING UP THE BEAD SEAT THERMO.
4-8-68	Jaw	STOP #24	BEFORE STOP: WHEEL (ROAD) WAS CLEANED; TIRE WAS CLEAN; REINFLATED TIRE FROM 252 TO 260 PSI; WHEEL ROTATES FREELY.

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B.F.GOODRICH AEROSPACE & DEFENSE PRODUCTS
Wheel and Brake Plant
Troy, Ohio

TEST NO. T1847

OPERATOR'S COMMENTS

Sheet No. 8 of 9

DATE	OPERATOR	REFERENCE	COMMENTS
4-8-68	JDS	Stop #25	Before Stop Clean Roadwheel & Tire clean Wheel & Brake
4-8-68	JDS	Stop #26	Before Stop Clean Roadwheel & Tire clean wheel & Brake
4-8-68	JDS	Stop #27	Before Stop - Clean Roadwheel & Tire Clean Wheel & Brake
			replaced #2 Rotor T.C. BRAKE CLEARANCE W/O PSI Top .115 Bottom .115
4-8-68	CW	BEFORE Stop #28	ROAD WHEEL CLEANED NEW TIRE WAS PUT ON BRAKE CLEANED OUT.
4-8-68	CW	BEFORE Stop #29	ROAD WHEEL CLEANED - TIRE CLEANED BRAKE CLEANED OUT WITH FORCED AIR.
			TIRE PRESSURE WAS 235 PSI REINFLATED TO 260 PSI.
4-8-68	CW	BEFORE Stop #30	ROAD WHEEL CLEANED - TEST WHEEL CLEANED - BRAKE CLEANED OUT WITH FORCED
			AIR - TIRE PRESSURE WAS 259 PSI
4-9-68	Jow	AFTER Stop #30	ROAD WHEEL WAS CLEANED BY C.W. WHEN BRAKE WAS 300° (AFTER TAKING OF COOLING PROFILE)
		& BEFORE STOP #31	WHEEL WAS TAKEN (PER S. LAWSON) OFF THE BRAKE AND THE BRAKE WAS TAKEN OFF AND DISASSEMBLED
			AND WEIGHED AND MEASURED. BEFORE W & M'S, THE DISC AND LINING CARRIER SLOTS WERE
			CLEANED OUT PER REQUEST. THE TIRE WAS NOT CHANGED SINCE NEW TIRE WAS PUT ON
			BEFORE STOP #28. WHEEL WOULD ROTATE FREELY WITH A TANG. FORCE OF 10 TO 5 lbs. TIRE WAS REINFLATED
			FROM 250 TO 262 PSI. WITH ABOVE WHILE BRAKE WAS DISASSEMBLED, S. LAWSON INSPECTED THE HEAT
			STACK ELEMENTS. PER B. RENZIES TELEPHONE CONVERSATION WITH S. LAWSON - USE BRAKE PRESSURE AS WAS
			USED ON THE LAST STOP (#30)
4-9-68	Jow	DURING STOP #31	BRAKE WAS NOT LET OUT UNTIL 8 MPH, CAUSING A SLIGHT PEAK OF TORQUE PLUS A GROANING
			FROM 15 MPH TO 8 MPH. THERMOS #1,3,5 (TORQUE PLATE) PEAKED AT THE START THEN SUDDENLY STARTED TO
			READ A FIGURE MUCH LOWER. THERMOS #6,8,10 (PRESSURE PLATE) DID NOT FUNCTION PROPERLY,
			HOWEVER THEY DID GIVE A READING CLOSE TO ROOM TEMPERATURE.
4/9/68	Jow	STOP #32	BEFORE STOP: ROAD WHEEL WAS CLEANED;
4/9/68	JDS	STOP #32	Wheel & Brake Cleaned, Tire cleaned T.C. fixed
4/9/68	JDS	STOP #33	Before wheel & Brake Cleaned Tire cleaned T.C. fixed Road wheel Cleaned
4-9-68	CW	BEFORE Stop #34	ROAD WHEEL, TEST WHEEL & BRAKE CLEANED. TIRE PRESSURE 260 PSI.
4-9-68	CW	BEFORE Stop #35	ROAD WHEEL, TEST WHEEL & BRAKE CLEANED. TIRE PRESSURE 260 PSI
4-9-68	CW	BEFORE Stop #36	ROAD WHEEL. TEST WHEEL & BRAKE CLEANED. TIRE PRESSURE 260 PSI
4-9-68	CW	BRAKE CLEARANCE AFTER STOP #36	Top .154 Bottom .135
4-9-68	CW	BEFORE Stop #37	ROAD WHEEL, TEST WHEEL & BRAKE CLEANED. FIX T.C.s ON ROTORS. TIRE
			PRESSURE WAS 255 PSI REINFLATED TO 260 PSI

EP65

B.F.GOODRICH AEROSPACE & DEFENSE PRODUCTS
Wheel and Brake Plant
Troy, Ohio

TEST NO. T-1862

OPERATOR'S COMMENTS

Sheet No. 7 of 9

DATE	OPERATOR	REFERENCE	COMMENTS
4-10-68	Jaw	AFTER Stop #37	COOLING PROFILE WAS TAKEN WITH FANS ON DURING AND AFTER STOP. THE 12-POINT RECORDER WAS TURNED OFF AT 00:33 AM AND THE 2-PEN RECORDER WAS TURNED OFF AT 00:15AM WHEN THE TEMPERATURES COOLED TO 300°F.
4-10-68	Jaw	STOP #38	BEFORE STOP: ROAD AND TEST WHEEL (TIRE) WERE CLEANED; INFLATION PRESSURE WAS OK; WHEEL WOULD ROTATE FREELY WITH A TANG. FORCE OF 10 TO 7 lbs; BRAKE AND WHEEL WAS "BLOWN OUT" WITH FORCED AIR.
4-10-68	Jaw	STOP #39	BEFORE STOP: ROAD AND TEST WHEEL (TIRE) WERE CLEANED; INFLATION PRESSURE WAS OK; WHEEL WOULD ROTATE FREELY WITH A TANG FORCE OF 10 lbs.; BRAKE AND WHEEL WAS "BLOWN OUT" WITH FORCED AIR. AFTER STOP: FANS WERE TURNED OFF AFTER THE STOP; BRAKE WAS PARKED WITH 1000 PSI (NOT PARK SPEC.). COOLING FANS AND PRESSURE WERE RELEASED WHEN THE BEAD SEAT TEMP. PEAKED; BEAD SEAT PEAKED OUT AT 05:31AM.
4-10-68	Jaw	STOP # 40	BEFORE STOP; ROAD WHEEL CLEANED; TIRE CLEANED; INFLATION PRESSURE OK; WHEEL ROTATES FREELY WITH A FORCE OF 10 TO 7 lbs.; BRAKE "DUST FREED" WITH FORCED AIR.
4-10-68	JDS	Stop #41	Brake Tore down To clean Slots Repair Rotor + stators T.C. Change Tire clean wheel + Road wheel
4-10-68	JDS	Stop #42	Conduct Hot + cold Static Torque Cleaned Road wheel + wheel + Tire cleaned Brake fixed @ T.C.
4-10-68	CW	BEFORE Stop #43	ROAD WHEEL, TEST WHEEL + BRAKE CLEANED. TIRE PRESSURE WAS 230 PSI REINFLATED TO 260 PSI
4-10-68	CW	BEFORE Stop #44	ROAD WHEEL, TEST WHEEL + BRAKE CLEANED, TIRE PRESSURE WAS 255 PSI REINFLATED 260 PSI
4-10-68	CW	BEFORE Stop #45	ROAD WHEEL, TEST WHEEL + BRAKE CLEANED, TIRE PRESSURE WAS OKAY.
4-10-68	CW	FLUID DISPLACEMENT	AFTER STOP #45 WAS 35 ML. W/1000 PSI
4-11-68	Jaw	STOP #46	OVERHAUL. BEFORE STOP; PLATE CHANGE, CLEANING OF ROAD WHEEL AND TEST WHEEL, TEAR DOWN OF BRAKE, CHANGING OF TIRE, AND CLEANING AND WEIGHING AND MEASURING OF THE BRAKE WERE IN EFFECT. WHEEL ROTATED FREELY. AFTER STOP; THERMOS RED AND BLUE CAUSED TROUBLE. BLUE READ OUT DID NOT TRACE DUE TO INK PROBLEMS; RED READ OUT THE OPPOSITE WAY DUE TO LEAD-IN PROBLEMS.
4-11-68	Jaw	STOP 47	ROAD WHEEL CLEANED; TIRE CLEANED; BRAKE "BLOWN OUT"; WHEEL ROTATES FREELY; TIRE REINFLATED FROM 235 TO 260 PSI.
4-11-68	R. Glow	STOP 45	PRIOR TO STOP #46, THE #1 STATOR (IN POSITION #3) WAS SENT TO THE TOOL ROOM & .030" WAS REMOVED FROM THE I.D. TEST WAS THEN RESUMED WITH THIS REWORKED STATOR. REWORK OCCURRED PER R. SIMS INSTRUCTIONS.

EP65

B.F.GOODRICH AEROSPACE & DEFENSE PRODUCTS
Wheel and Brake Plant
Troy, Ohio

TEST NO. T-1867

OPERATOR'S COMMENTS

Sheet No. 8 OF 9

DATE	OPERATOR	REFERENCE	COMMENTS
4-11-68	R. [illegible]	STOP #47	AFTER THIS STOP, THE BRAKE WAS TORN DOWN. THE #1 & #3 STATORS HAD TO BE PRIED OFF THE TORQUE TUBE. ALL THREE (3) STATORS WERE SENT TO THE TOOL ROOM FOR REWORK WHICH CONSISTED OF REMOVING .125" OF MATERIAL FROM THE CARRIER I.D. THE HEAT SINK ELEMENTS WERE THEN CLEANED UP (INCLUDING ROTORS & STATORS) AND THE STATOR LUGS WERE SUBJECTED TO A DEBURR GUN TO ALLOW THEM TO MOVE ~~[illegible]~~ EASIER IN THE TORQUE TUBE SLOTS. STAINLESS STEEL T'COUPLES WERE REPLACED WITH STD. T'COUPLES.
4-11-68	R. [illegible]	STOP 46 & 47	IT WAS DISCOVERED BY THE WRITER, AFTER STOP #47, THAT THE PANEL PRESSURE RECORDER HAD BEEN TAMPERED WITH AFTER STOP #45 & PRIOR TO STOP #46. THIS WOULD HAVE OCCURRED B/T 2220 HRS 4-10-68 AND 0510 HRS 4-11-68. THE GAIN ON THE PRESSURE RECORDER WAS DECREASED SO THAT WHEN THE PUMP WAS OPERATING AT 1100 PSI, THE PANEL RECORDER ONLY INDICATED 1000 PSI. THIS CONDITION EXSISTED DURING STOP #46 & #47 ONLY. THE RECORDER WAS RECALIBRATED FOR STOP #48.

EP65

B.F.GOODRICH AEROSPACE & DEFENSE PRODUCTS
Wheel and Brake Plant
Troy, Ohio

TEST NO. T-1867

OPERATOR'S COMMENTS

Sheet No. 9 of 9

DATE	OPERATOR	REFERENCE	COMMENTS
4-11-68	CWW	BEFORE STOP #49	ROAD WHEEL, TEST WHEEL + BRAKE CLEANED. TIRE PRESS WAS 260 PSI
4-11-68	CWW	BEFORE STOP #50	ROAD WHEEL, TEST WHEEL + BRAKE CLEANED. TIRE PRESS WAS 260 PSI
4-11-68	CWW	FLUID DISPLACEMENT AFTER STOP #50 W/1000 WAS 39 ML.	
4-11-68	CWW	BEFORE RTO #1#2	BRAKE WAS DISSAMBLED. STATORS WAS CLEANED OUT ON ID & FEW TC'S
			WAS REPLACED. NEW TIRE WAS PUT ON. ROAD WHEEL WAS
			CLEANED. TIRE PRESSURE WAS 270 PSI PER (R Gloor)
4-11-68	CWW	THERMOCOUPLES ON RTO #1#2 ON TUBE WELL, BEADSEAT, + FUSE PLUG WAS HOOKED	
			UP BACKWARD. POLARITY WAS REVERSED AFTER STOP WAS MADE
			WHICH WE GOT TWO PEAKS ONE HAD PEAKED BEFORE WE GOT
			THEM REVERSED.

EP65

B.F.GOODRICH AEROSPACE & DEFENSE PRODUCTS
Wheel and Brake Plant
Troy, Ohio

BRAKE TEST LOG | TEST NO. T-1867 | Sheet 1 OF | Date 4 4 ... F

REQUIREMENTS:

LANDING VELOCITY 151 mph
STOP TIME 22.1 sec
STOP DISTANCE ______ ft

PRESSURE: 150 psi back
______ psi min.
1050 psi max.

OTHER MINIMUM TIME REQ'D B/T STOPS IS 6.5 HOURS

	Stop No.	Log Time	Landing Velocity mph	Brake Press. psi	Stop Time sec	+ Stop − ~~Distance~~ Time	Torque Avg. lb ft	Torque Peak lb ft	Red Center Stator Initial	Red Center Stator Peak	Piston Housing Initial	Piston Housing Peak	~~Torque Plate~~ 3 Initial	3 Peak	4	5	6	7	8	9	10	SS 11	12	Blue
Jaw	[illegible]	0240	110	300	16.0		2580	2760	64	328	70	76	105	108	80	109	121	78	120	80	120	76	90	179
Jaw	[illegible]	0408	60	150	15.0		3600	3640	88	410	71	90	130	130	80	130	183	81	182	90	182	90	90	300
Jaw	[illegible]	0541	80	[illegible]	18.9		3840	4080	65	656	70	142	282	282	129	281	319	130	319	142	319	148	142	450
	[illegible]	1000	100	[illegible]	22.9		3,040	4,320	82	995	105	156	386	381	130	386	390	135	391	160	393	162	160	620
CW	1	1608	151	700	22.3	-0.2	5400	7560	90	1330	109	221	590	597	201	591	655	200	653	280	657	300	214	①
CW	2	2017	151	710	21.3	+0.6	5760	7980	75	1280	100	203	600	600	153	600	671	186	670	250	670	261	227	1140
1-5-66 CW	3	2320	151	710	23.1	-0.4	5460	7020	90	1247	68	217	581	585	150	581	695	210	699	274	699	297	237	1172
Jaw	4	0240	151	735	21.8	-0.1	5700	7200	65	1222	102	290	740	741	—	735	830	220	835	264	832	327	282	1149
Jaw	5	0624	151	730	22.4	-0.4	5580	6900	50	1193	52	320	851	851	260	852	888	320	899	312	888	342	326	1185
DS	6	10:55	151	730	21.0	+0.7	5880	7,680	58	1175	62	191	537	535	136	536	653	150	655	231	656	231	307	1111
DS	7	130	151	720	21.6	+1.2	5760	6,720	60	1160	60	210	520	521	140	521	674	186	672	269	671	255	225	1155
CW	8	1555	151	730	21.7	+0.6	5640	7360	69	1310	70	231	559	590	157	590	690	184	690	280	690	300	243	1193
CW	9	1834	151	730	22.4	-0.2	5460	6420	70	1100	55	215	556	559	152	555	720	193	721	262	720	256	237	①
CW	10	2110	151	750	22.5	-0.6	5760	7260	79	1453	59	313	890	890	287	890	915	314	918	331	916	300	329	1190
1-6-66 Jaw	11	0255	151	770	21.5	+0.0	5880	7200	70	—	60	215	491	492	140	492	727	159	726	235	728	249	221	1257
Jaw	12	0523	151	770	21.9	+0.2	5760	7200	72	1260	58	209	513	513	140	513	692	149	698	222	698	228	218	1218
DS	13	0825	151	760	20.5	+1.8	6,000	7320	—	—	63	212	~~33~~	—	140	510	713	152	715	138	714	250	221	1155
DS	14	1100	151	740	21.8	+2.1	5760	6,600	—	1200 Approx	63	220	490	500	142	500	722	183	718	165	720	300	230	1415
DS	15	1420	151	730	20.0	+4.2	5880	6,360	80	1224	70	326	839	839	300	839	905	349	906	350	906	390	334	1280
CW	16	1706	151	700	21.5	+4.8	5640	6720	83	1207	71	240	532	535	157	534	757	176	758	253	757	300	250	1225
CW	17	2008	151	700	23.5	+3.4	5400	6180	80	1220	62	226	535	540	144	551	745	170	748	263	748	300	235	1176
CW	18	2354	151	700	22.8	+2.7	5580	6480	84	1257	65	220	532	532	142	534	720	168	720	260	720	305	236	1281

REMARKS ① T'COUPLE INOPERATIVE   Stop # 15 Tire was changed before stop.

EP355

B.F.GOODRICH AEROSPACE & DEFENSE PRODUCTS
Wheel and Brake Plant
Troy, Ohio

BRAKE TEST LOG

TEST NO. T-1867

Sheet 2 of
Date 4-7-68

REQUIREMENTS:

LANDING VELOCITY 151 mph
STOP TIME 22.1 sec
STOP DISTANCE ______ ft

PRESSURE: 150 psi back
______ psi min.
1050 psi max.

OTHER 2.5 B/T Stops

	Stop No.	Log Time	Landing Velocity mph	Brake Press. psi	Stop Time sec	Stop Distance ft	TORQUE Avg. lb ft	TORQUE Peak lb ft	Red TEMPERATURES °F 1 · 3 Center Stator Initial	Center Stator Peak	Piston Housing Initial	Piston Housing Peak	Torque Plate Initial	Torque Plate Peak	OTHER PEAK TEMPERATURES °F 4	5	6	7	8	9	10	11	12	Blue
DS	19	0845	151	700	22.3	+2.5	5760	6,240	72	1295	65	270	869	870	225	869	950	310	950	312	951	370	289	1390
DS	20	1120	151	680	21.2	+3.4	5,500	6,000	80	1250	72	236	545	546	161	542	711	162	712	250	711	289	240	122
OW	W15	1818	100	300	37.7		1,520	3,300	90	600	70	136	287	287	109	286	373	104	390	136	390	121	131	818
CW	21	2012	151	710	23.6	+1.9	5280	6000	122	1347	71	238	530	531	160	531	749	186	750	271	749	261	249	125
CW.	22	2309	151	710	22.0	+2.0	5700	6000	46	1160	72	239	515	519	171	523	743	212	732	290	737	301	249	1312
4-8-68 Jaw	23	0234	151	710	22.0	+2.1	5700	6180	40	1233	67	303	766	769	180	768	879	240	880	308	880	370	259	1110
Jaw	24	0555	151	720	22.7	+1.5	5400	6000	90	1390	73	251	578	593	170	590	755	185	753	270	753	270	259	1255

REMARKS

EP355

B.F. GOODRICH AEROSPACE & DEFENSE PRODUCTS
Wheel and Brake Plant
Troy, Ohio

BRAKE TEST LOG

TEST NO. T-1867

Sheet 2

Date ______

REQUIREMENTS:

LANDING VELOCITY 151 mph

STOP TIME 22.1 sec

STOP DISTANCE ______ ft

PRESSURE: 150 psi back

______ psi min.

1030 psi max.

OTHER 2½ HRS MINIMUM TIME B/T STOPS

Stop No.	Log Time	Landing Velocity mph	Brake Press. psi	Stop Time sec	+ − Stop ~~Distance~~ TIME	TORQUE Avg. lb ft	TORQUE Peak lb ft	RED TEMPERATURES °F 1 3 Center Stator Initial	Center Stator Peak	Piston Housing Initial	Piston Housing Peak	Torque Plate ~~Initial~~	Torque Plate Peak	OTHER PEAK TEMPERATURES °F FP 4	5	6	7	8	9	10	BS 11	12	BLUE
19	0845	151	700	22.3	+2.5	5760	6240	72	1295	65	270	869	870	225	869	950	310	950	312	951	370	288	1390
20	1120	151	680	21.2	+3.4	5500	6000	80	1250	72	236	545	546	161	542	711	162	712	250	711	289	240	1220
21	2012	151	710	23.6	+1.9	5280	6000	122	1347	71	238	530	531	160	531	749	186	750	271	749	261	249	1251
22	2309	151	710	22.0	+2.0	5700	6000	96	1260	72	239	510	519	171	523	743	212	732	290	737	301	245	1312
23	0234	151	710	22.0	+2.1	5200	6180	90	1233	67	303	766	769	180	768	879	240	880	308	880	370	289	1410
24	0555	151	720	22.7	+1.5	5400	6000	90	1390	73	251	588	593	170	590	755	185	753	270	753	270	259	1355
25	0830	151	720	21.0	+2.6	5550	6,720	100	1265	65	311	903	904	289	905	925	329	926	351	927	389	322	[illegible]
26	1100	151	710	22.0	+2.7	5720	6000	100	1229	89	260	571	572	170	570	719	217	720	296	720	304	270	1450
27	1415	151	710	22.3	+2.5	5520	6,360	83	1140	88	252	621	618	181	600	762	200	765	290	766	295	270	1372
28	1756	151	715	21.7	+2.9	5580	6300	80	1270	85	262	601	600	183	600	786	204	783	284	783	290	270	1230
29	2029	151	710	22.8	+2.2	5340	6000	80	1223	82	258	536	540	181	538	780	234	780	313	780	351	270	1305
30	2303	151	720	25.1	−0.8	5040	5400	80	1424	82	345	950	950	325	950	950	380	951	418	951	379	357	1191
31	0543	151	720	24.0	−2.7	5160	6720	79	1301	80	262	602	611	168	624	—	221	—	321	—	279	280	1259
32	0945	151	740	22.1	−2.7	5460	6,000	84	1195	85	229	599	600	161	598	—	171	—	245	—	250	246	1190
33	1331	151	740	23.1	−3.7	5,520	6,000	80	1240	81	236	560	560	159	560	704	203	707	299	707	278	250	1445
34	1605	151	770	23.0	−4.6	5640	6000	80	1350	85	345	890	840	329	890	951	370	952	430	956	380	358	1255
35	1841	151	800	22.4	−4.9	5700	6120	87	1277	84	249	660	657	170	655	759	190	759	280	759	280	258	1500
36	2114	151	815	22.9	−5.7	5400	5550	80	1360	85	250	630	637	176	640	780	187	780	280	780	250	261	1300
37	0005	151	835	21.7	−5.3	5580	6000	80	1290	90	252	640	643	180	644	770	230	774	325	770	301	265	1290
38	0235	151	835	22.8	−6.0	5200	6000	81	1280	92	251	642	642	181	644	820	192	821	269	820	289	270	1150
39	0517	151	855	21.8	−5.7	5580	6600	84	1268	90	300	845	844	281	847	948	419	950	360	944	341	312	1219
40	0750	151	850	24.0	−7.6	5000	6,000	85	1259	91	240	683	684	170	682	815	147	820	254	819	170	245	1130
41	1220	151	875	22.2	−7.7	5040	6,120	85	1205	79	323	874	875	—	875	911	290	911	565	910	340	309	1329

REMARKS ______

EP355

B.F.GOODRICH AEROSPACE & DEFENSE PRODUCTS
Wheel and Brake Plant
Troy, Ohio

BRAKE TEST LOG

TEST NO. T-1867

Sheet 3

Date

REQUIREMENTS:

LANDING VELOCITY 151 mph

STOP TIME 22.1 sec

STOP DISTANCE ft

PRESSURE: 150 psi back

psi min.

1050 psi max.

OTHER 2 1/2 HRS MINIMUM
TIME B/T STOPS

	Stop No.	Log Time	Landing Velocity mph	Brake Press. psi	Stop Time sec	Stop Distance ft	TORQUE Avg. lb ft	TORQUE Peak lb ft	Red TEMPERATURES °F Center Stator Initial	Center Stator Peak	Piston Housing Initial	Piston Housing Peak	1 3 Torque Plate Initial	Torque Plate Peak	OTHER PEAK TEMPERATURES °F FP 4	5	6	7	8	9	10	BS 11	12	Blue
	42	1450	151	880	24.5	-10.1	4,800	5,760	95	1232	90	220	726	727	170	724	689	155	689	324	689	241	230	1130
cw	43	1720	151	920	25.7	-13.7	4800	6360	92	1087	77	370	722	722	200	722	722	222	715	458	715	318	269	1235
cw	44	1950	158	460	25.5	-17.1	5040	6180	82	1330	77	232	752	758	169	757	691	183	681	401	679	270	232	1052
cw	45	2220	151	940	26.8	-20.8	4800	7230	94	1138	80	332	1000	1000	317	1000	949	342	945	522	945	376	342	1155
				2	22.02			~~5040~~																
[illegible]	46	0510	156.9	1000	31.2		4440	5040	71	-	75	241	969	979	190	979	890	450	888	305	886	241	250	NO INK
[illegible]	47	0750	156.9	1000	30.5		4,800	6,840	80	1080	46	180	851	853	200	858	909	425	905	305	905	220	264	1360
[illegible]	48	1535	156.9	1000	35.1		4,080	4,800	76	1500	100	387	1260	1260	367	1263	1068	418	1062	601	1068	420	405	1260
cw	49	1730	156.9	1000	44.9		3000	4080	90	1460	100	320	1320	1334	232	1344	941	237	934	440	940	307	308	1191
cw	50	1900	156.9	1000	34.8		3300	5760	87	1020	91	270	951	955	199	956	951	238	954	470	950	310	289	1249
cw	51	2208	59	1000	17.4		3840	6480	80	440	90	111	310	309	102	311	259	80	257	→	254	90	100	340
cw	52	2216	161.8	1000	141.0		1200	2820	282	1912	110	400	[illegible]	[illegible]	403	1511	1203	760	1234	660	1234	460	405	1346
													1510	1503						①				

REMARKS 2228 FUSE PLUG BLEW ① Tq WAS HOOKEDUP BACKWARD. DIDN'T GET PEAK
2229 FUSE PLUG BLEW. READING WHEN IT WAS SWITCH AROUND.

EP355

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B.F.GOODRICH AEROSPACE & DEFENSE PRODUCTS
Wheel and Brake Plant
Troy, Ohio

BRAKE TEST LOG

TEST NO. T-1867 (RTO)

Sheet ______
Date 17 APR 68

REQUIREMENTS:

LANDING VELOCITY 59.0/171.6 mph
STOP TIME 10.2/25.2 sec
STOP DISTANCE ______ ft

PRESSURE: 150 psi back
______ psi min.
1050 psi max.

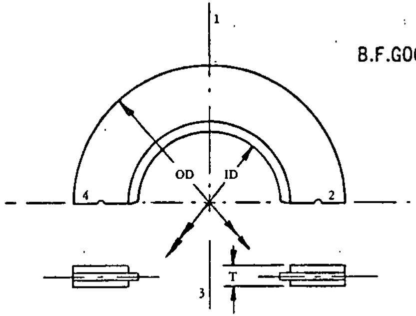
OTHER ______

Stop No.	Log Time	Landing Velocity mph	Brake Press. psi	Stop Time sec	Stop Distance ft	TORQUE Avg. lb ft	TORQUE Peak lb ft	RED PEN TEMPERATURES °F Center Stator Initial	Center Stator Peak	Piston Housing Initial	Piston Housing Peak	Torque Plate Initial	Torque Plate Peak	OTHER PEAK TEMPERATURES °F FA 4	TP 5	PP 6	FP 7	PP 8	TW 9	PP 10	BS 11	FLW 12	BLUE
WI 1	2204	58	350	14.0		3960	4440	80	271	90	100	150	150	100	150	151	100	151	—	152	109	100	279
WI 2	2227	80	450	18.0		4800	5640	118	610	95	108	256	256	110	255	281	109	284	—	189	124	109	553
WI 3	2303	100	500	22.2		5400	5640	120	840	95	108	360	360	120	359	400	128	400	—	400	162	118	739
RTO1	0004	60.4	700	9.7	410.9	6840	8400	92	371	91	116	193	197	100	194	221	100	221	—	221	108	115	372*
RTO2	0013	171.8	1000	26.4	3229.0	6720	8640	249	1804	112	471	1115	1117	469	1118	1162	445	1166	—	1168	540	465	920

REMARKS * TEMP PEAK FOR BLUE PEN #1 R.T.O. WAS 372°
0026 FUSE PLUG BLEW 2 FUSE PLUG BLEW 0027

EP355

227



B.F.GOODRICH AEROSPACE & DEFENSE PRODUCTS
Wheel and Brake Plant
Troy, Ohio

WEAR DATA

Disk ✓ _ Lining

TEST NO. T-1867
Sheet 1 of 5

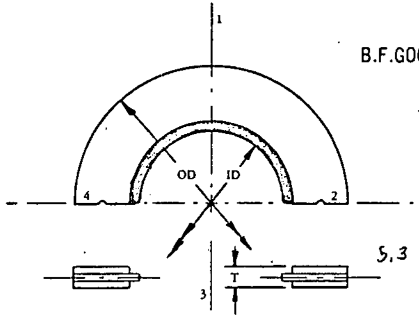
NOMENCLATURE

Disk Assy No. 134-44
Carrier No. —
Segment No. 133-302
Friction Material Steel

Carrier & Lining Assy No. /
Carrier No.
Lining No.
Friction Material

BRAKE LOCATION NO.	STOP COMPLETED	WT. LBS.	OD INS. 11"	ID INS. 7"	THICKNESS Position 1 in.	2 in.	3 in.	4 in.	Avg. in.	WEAR Total ins.	Per Stop Per Surf. ins.	REMARKS
1	New	10.8	".856/.424	7.085/.152	.508	.508	.508	.503				
After	20 Stops	10.4	".942/.910	7.407/.400	.487	.490	.490	.491				
1	30	10.1	.936-.890	.355-.461	.486	.484	.487	.483				
1	45	9.8	.715-.955	.276-.530	.484	.486	.484	.483				
1	52	9.5	.638/12.068	.180/.100	.468	.466	.474	.467				
2	New	10.8	".860/.420	7.075/.148	.505	.508	.508	.508				
After	20 stops	10.4	".957/.949	7.476/.476	.495	.495	.496	.494				
2	30	10.3	.861-.914	.421-.452	.491	.492	.493	.493				
2	45	10.2	.940-.956	.397-.525	.497	.500	.496	.499				
2	52	10.1	.800/12.078	.082/.340	.518	.520	.516	.519				
3	New	10.4	".915/.880	7.115/.125	.508	.508	.508	.508				
After	20 stops	10.5	".977/.936	7.475/.441	.495	.495	.495	.495				
3	30	10.3	.955-.944	.458-[illegible]	.490	.491	.490	.489				
3	45	10.2	.882-.985	.405-.510	.487	.488	.495	.490				
3	52	10.1	12.072/.034	.368/.388	.524	.524	.524	.524				
4	New	10.8	".912/.905	7.120/.125	.509	.509	.510	.509				
After	20 stops	10.5	".926/.919	7.425/.437	.497	.498	.496	.497				
4	30	10.3	.937-.947	.470-.475	.487	.488	.490	.488				
4	45	9.9	.932-.900	.507-.436	.490	.491	.490	.490				
4	52	9.8	.925/12.300	.306/.381	.496	.494	.494	.496				

EP215



B.F.GOODRICH AEROSPACE & DEFENSE PRODUCTS
Wheel and Brake Plant
Troy, Ohio

WEAR DATA

Disk _ ✓ Lining

TEST NO. T-1867
Sheet 2 of 8

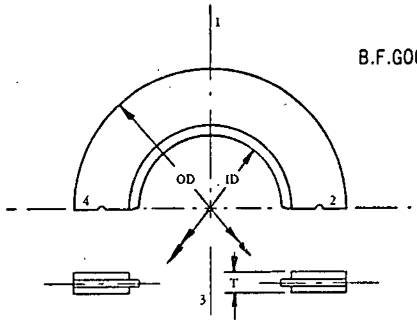
NOMENCLATURE

Disk Assy No. /
Carrier No. /
Segment No. /
Friction Material /

Carrier & Lining Assy No. 244-270
Carrier No. 261-268
Lining No. 5093 A
Friction Material IRON BASE

BRAKE LOCATION NO.	STOP COMPLETED	WT. LBS.	OD INS. 11"	ID INS. 6"	THICKNESS Position 1 in.	2 in.	3 in.	4 in.	Avg. in.	WEAR Total ins.	Per Stop Per Surf. ins.	REMARKS
P.P.	New	9.2	".890/.903	6.655/.670	.561	.563	.560	.557				
AFTER	20 stops	9.1	".894/.877	6.657/.657	.556	.528	.521	.538				
	30	9.0	".954-.983	6.655-.667	.517	.522	.504	.515				
	45	8.5	.984-.972	.658-.658	.510	.486	.480	.481				
1	New	7.3	".870/.868	6.690/.652	.446	.446	.446	.446				
AFTER	20 stops	~~7.0~~	~~".8??/.869~~	~~6.651/.653~~	~~.414~~	~~.413~~	~~.412~~	~~.414~~				
	~~20~~	6.6	".862/.920	6.654/.656	.396	.383	.353	.391				
	30	6.0	[illegible]	.570-.588	.367	.357	.345	.350				
	45	5.6	.626-.647	.440-.441	.314	.314	.309	.318				
2	New	7.3	".875/.880	.646/.690	.444	.444	.443	.444				
AFTER	20 stops	6.8	".871/.900	6.648/.648	.419	.411	.405	.400				
	30	6.4	.811-.842	.572-.625	.397	.400	.387	.370				
	45	5.6	.687-.710	.453-.500	.326	.321	.313	.314				O.D. SLOTS closed — I.D. SLOTS OPEN
3	New	7.4	".876/.885	6.481/.690	.445	.446	.445	.445				
AFTER	20 stops	7.0	".877/.869	6.653/.653	.414	.413	.418	.414				
	30	6.4	.779-.807	.580-.605	.401	.384	.377	.390				
	45	5.7	.675-.715	.417-.510	.344	.310	.312	.330				I.D. + O.D. SLOTS CLOSING
T.P.	New	18.0										
AFTER	20 stops	17.9										
	30	17.7										
	45	17.4										

EP215



B.F.GOODRICH AEROSPACE & DEFENSE PRODUCTS
Wheel and Brake Plant
Troy, Ohio

WEAR DATA

Disk _ ✓ Lining

TEST NO. T-1867
Sheet 3 of 5

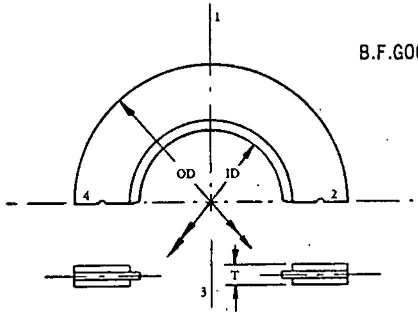
NOMENCLATURE

Disk Assy No. ___
Carrier No. ___
Segment No. ___
Friction Material ___

Carrier & Lining Assy No. 244-270
Carrier No. 261-268
Lining No. 5043 A
Friction Material IRON BASE

BRAKE LOCATION NO.	STOP COMPLETED	WT. LBS.	OD INS.	ID INS.	THICKNESS Position 1 in.	2 in.	3 in.	4 in.	Avg. in.	WEAR Total ins.	Per Stop Per Surf. ins.	REMARKS
T.P	52	12.4										
1	52	5.3	—	—	296	296	297	295				BROKEN IN TWO
2	52	5.3	752/820	928/928	306	298	298	295				
3	52	5.3	668/700	929/941	305	294	295	361				
P.P	52	8.4	948/961	632/624	499	465	457	468				

EP215



B.F.GOODRICH AEROSPACE & DEFENSE PRODUCTS
Wheel and Brake Plant
Troy, Ohio

(RTO)

WEAR DATA

Disk ✓ _ Lining

TEST NO. T-1867
Sheet 4 OF 5

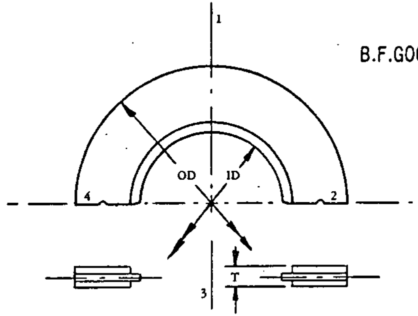
NOMENCLATURE

Disk Assy No. 133-44
Carrier No.
Segment No. 133-302
Friction Material ST.

Carrier & Lining Assy No. /
Carrier No.
Lining No.
Friction Material

BRAKE LOCATION NO.	STOP COMPLETED	WT. LBS.	OD INS. 11	ID INS. 7	THICKNESS Position 1 in.	THICKNESS Position 2 in.	THICKNESS Position 3 in.	THICKNESS Position 4 in.	Avg. in.	WEAR Total ins.	WEAR Per Stop Per Surf. ins.	REMARKS
1	NEW	10.6	903/923	394/440	503	503	503	503				
1	2RTO	10.7	900/924	292/345	515	492	493	504				
2	NEW	10.6	935/905	434/406	503	503	502	502				
2	2RTO	10.8	930/932	095/170	541	517	546	520				
3	NEW	10.6	911/915	413/415	504	504	504	504				
3	2RTO	10.9	895/855	372/396	521	560	506	512				
4	NEW	10.6	940/914	421/408	503	503	503	503				
4	2RTO	10.7	958/945	350/372	502	503	504	506				

EP215



B.F.GOODRICH AEROSPACE & DEFENSE PRODUCTS
Wheel and Brake Plant
Troy, Ohio

(RTO)

WEAR DATA

Disk __ ✓ Lining

TEST NO. T-1867
Sheet 5 of 5

NOMENCLATURE

Disk Assy No. ____
Carrier No. ____
Segment No. ____
Friction Material ____

Carrier & Lining Assy No. 244-270
Carrier No. 201-268
Lining No. 5043A
Friction Material IRON BASE

BRAKE LOCATION NO.	STOP COMPLETED	WT. LBS.	OD INS.	ID INS.	THICKNESS Position 1 in.	2 in.	3 in.	4 in.	Avg. in.	WEAR Total ins.	Per Stop Per Surf. ins.	REMARKS
			11.	6.								
PP	NEW	9.1	875/882	632/660	553	557	553	552				
	2RTO	9.0	875/885	630/640	.525	.536	539	549				
1	NEW	7.2	865/875	680/677	444	444	444	444				
	2RTO	5.9										BROKEN
2	NEW	7.2	870/875	696/680	444	444	444	444				
	2RTO	6.2	965/885	700/690	389	332	336	354				
3	NEW	7.2	870/865	687/681	444	449	449	449				
	2RTO	6.9	872/900	694/715	439	428	475	438				
TP	NEW	16.8										
	2RTO	16.8										

EP215

B.F.GOODRICH AEROSPACE & DEFENSE PRODUCTS
Wheel and Brake Plant
Troy, Ohio

STATIC TORQUE

TEST NO. T-1867

Sheet 1 of 1

Brake Assembly No. 2-1162-3

Lining No. 244-270
Lining Material 5043A

Disk No. 134-44
Disk Material STEEL

Date	After Stop No.	Amb. Temp. °F	Brake Temperature Hot °F	Brake Temperature Cold °F	Brake Pressure Hot psi	Brake Pressure Cold psi	Static Torque Hot lb ft	Static Torque Cold lb ft	REMARKS
4-5-68	4	65	1000+		1000		* 11040		12.0" DYN. PANEL READING
4-5-68	4	65		80°		1000		17040	" " " " (SEE EP65 #2)
4-8-68	23	67	1000+		1000		7620		12.0" DYN PANEL READING
4-8-68	23	67		70		1000		16980	" " " "
4-10-68	41	68	1000+		1000		6,840		
4-10-68	41	68		70		1000		18,600	Panel

EP68

B.F.GOODRICH AEROSPACE & DEFENSE PRODUCTS
Wheel and Brake Plant
Troy, Ohio

BRAKE TEST LOG

TEST NO. T-1867

Date ______

REQUIREMENTS:

LANDING VELOCITY 151 mph
STOP TIME 22.1 sec
STOP DISTANCE ______ ft

PRESSURE: ______ psi back
______ psi min.
1000 psi max.

OTHER ______

Stop No.	Log Time	Landing Velocity mph	Brake Press. psi	Stop Time sec	Stop Distance ft	TORQUE		TEMPERATURES °F						OTHER PEAK TEMPERATURES °F									
						Avg. lb ft	Peak lb ft	Center Stator		Piston Housing		Torque Plate											
								Initial	Peak	Initial	Peak	Initial	Peak	4	5	6	7	8	9	10	11	12	13
42	1450		880	22.5	+5.0	5640	5760	95	1232	90	220	720	707	170	724	689	155	689	304	689	314	290	1230
43	1720		880	22.7	+4.4	5620	6360	92	1287	77	270	712	710	200	722	722	222	715	308	715	318	305	1310
44	1950		880	22.9	+3.6	5590	6180	82	1330	77	232	740	735	169	757	681	183	681	301	679	307	304	1380
45	2220		880	23.5	+2.2	5400	6540	94	1338	80	312	780	785	317	780	949	255	945	306	945	317	314	1440
46	0510	156.9	900	23.2	-.2	5200	6756	71	~~0~~	75	241	860	870	295	879	890	245	888	315	886	341	~~0~~	1480
47	0750	156.9	925	23.3	-.5	5100	6840	80	1410	96	280	890	895	310	898	909	270	905	320	905	345	320	1490
48	1050	156.9	950	23.0	-.5	5150	6900	76	1500	100	274	880	890	305	873	900	255	900	317	900	350	325	1475
49	1325	156.9	1000	22.7	-.2	5300	6950	81	1570	98	270	870	895	315	883	910	265	910	325	910	340	320	1500
50	1440	156.9	1000	23.5	-.7	5250	6780	82	1590	95	275	890	900	320	890	905	260	905	320	905	345	330	1550
51	2208	59	1000	9.8		6080	8900	80	440	90	111	85	309	102	311	259	80	257	~~0~~	254	70	100	~~0~~
52	2216	161.8	1000	46.8	*	4500	7600	282	1912	110	400	304	1510	403	1511	1203	760	1234	~~0~~	1238	460	405	~~0~~

REMARKS ~~0~~ thermocouple out

* Test run for information only (Worn heat sink per 5013-G). New brake will meet 25.2 sec. RTO.

EP355

B.F.GOODRICH AEROSPACE & DEFENSE PRODUCTS
Wheel and Brake Plant
Troy, Ohio

BRAKE TEST LOG

TEST NO. T-867

Sheet 2 of 3
Date 4/4/68

REQUIREMENTS:

LANDING VELOCITY 151 mph
STOP TIME 22.1 sec
STOP DISTANCE ______ ft

PRESSURE: ______ psi back
______ psi min.
1000 psi max.

OTHER ______

Stop No.	Log Time	Landing Velocity mph	Brake Press. psi	Stop Time sec	Adcum Time	TORQUE Avg. lb ft	TORQUE Peak lb ft	Center Stator Initial	Center Stator Peak	Piston Housing Initial	Piston Housing Peak	Torque Plate 1	Torque Plate 3	4	5	6	7	8	9	10	11	12	13
19	0845		700	22.0	+7.9	5760	6240	72	1295	65	270	809	810	225	809	950	310	950	312	951	345	290	1340
20	1120		680	21.2	+8.8	5900	6300	80	1250	72	236	545	546	161	542	711	162	712	250	711	279	240	1220
21	2012		710	22.0	+8.9	5780	6350	122	1347	71	238	530	531	160	531	749	186	750	271	749	281	249	1251
22	2309		710	22.0	+9.0	5760	6100	96	1260	72	239	515	519	171	523	743	212	732	290	737	301	249	1312
23	0234		710	22.0	+9.1	5760	6180	90	1233	67	283	766	769	180	768	879	240	880	308	880	317	289	1410
24	0555		720	22.6	+8.6	5500	6000	90	1390	73	251	598	593	170	590	755	185	753	270	753	275	259	1355
25	0830		720	21.0	+9.7	5980	6720	100	1265	65	280	803	804	289	805	925	309	926	315	927	339	322	-0-
26	1100		710	22.0	+9.8	5760	6000	100	1229	89	260	571	572	180	570	719	217	720	296	720	309	270	1450
27	1415		710	22.3	+9.6	5620	6560	83	1140	88	252	621	618	181	600	762	200	765	290	766	295	270	1372
28	1756		715	21.7	+10.0	5680	6300	80	1270	85	262	601	600	183	600	786	204	783	284	783	290	270	1230
29	2029		710	22.7	+9.4	5560	6000	80	1223	82	258	536	540	181	538	780	239	780	293	780	315	270	1305
30	2303		720	23.1	+8.4	5450	6100	80	1324	82	305	950	950	325	950	950	215	951	285	951	317	307	1391
31	0543		720	23.2	+7.3	5480	6720	79	1301	80	262	603	611	168	624	-0-	221	-0-	281	-0-	299	280	1259
32	0945		740	22.1	+7.3	5740	6000	80	1195	85	229	594	600	161	598	-0-	171	-0-	245	-0-	250	246	1190
33	1331		740	23.1	+6.3	5460	6000	80	1240	81	236	560	560	159	560	704	203	707	277	707	278	250	1320
34	1605		770	22.0	+6.4	5740	6000	80	1350	85	245	809	809	329	809	951	270	957	330	956	340	320	1288
35	1841		800	22.1	+6.4	5780	6120	87	1277	84	249	660	657	170	655	759	190	759	280	759	285	258	1300
36	2114		815	22.2	+6.3	5780	5880	80	1360	85	250	630	631	176	640	780	187	780	280	780	285	261	1300
37	0005		835	21.7	+6.7	5880	6000	80	1290	90	252	640	643	180	644	770	230	774	305	770	315	265	1290
38	0235		835	22.4	+6.4	5680	6000	81	1280	92	257	642	642	181	644	820	192	821	289	820	290	270	1150
39	0517		855	21.8	+6.7	5880	6600	84	1269	90	300	895	894	281	887	948	275	950	315	948	334	312	1219
40	1750		850	23.5	+5.3	5380	6000	85	1289	91	240	683	684	170	682	815	147	820	254	819	275	245	1230
41	1220		875	22.0	+5.4	5760	6120	85	1205	79	223	807	808	-0-	808	911	-0-	911	-0-	910	314	309	1329

REMARKS
-0- Thermocouple out

EP355

B.F.GOODRICH AEROSPACE & DEFENSE PRODUCTS
Wheel and Brake Plant
Troy, Ohio

PRELIMINARY

BRAKE TEST LOG TEST NO. T-1867

Sheet 1 of 3
Date 4-4-68

REQUIREMENTS:

LANDING VELOCITY ______ mph
STOP TIME 22.1 sec
STOP DISTANCE ______ ft

PRESSURE: ______ psi back
______ psi min.
1000 psi max.

OTHER ______

Stop No.	Log Time	Landing Velocity mph	Brake Press. psi	Stop Time -sec	Accum Time	TORQUE Avg. lb ft	TORQUE Peak lb ft	TEMPERATURES °F Center Stator Initial	Center Stator Peak	Piston Housing Initial	Piston Housing Peak	Torque Plate (1)	Torque Plate (3)	OTHER PEAK TEMPERATURES °F 4	5	6	7	8	9	10	11	12	13
WI 1	0240	40	300	16.0		2580	2760	69	328	70	78	105	108	80	109	121	78	120	80	120	76	80	179
2	0408	60	350	15.0		3600	3840	88	410	71	90	130	130	80	130	183	81	182	90	182	90	90	300
3	0541	80	400	18.9		3840	4800	85	656	70	142	282	282	129	281	319	132	319	142	319	148	142	450
4	1000	100	450	22.9		3040	4320	82	995	105	156	386	381	130	386	390	135	391	160	393	162	160	620
1	1608	151	700	22.2	-.1	5740	7560	90	1330	109	221	590	597	201	591	655	200	659	280	657	290	244	⊖
2	2017		710	21.2	+.8	5860	7980	75	1280	100	203	600	600	153	600	671	186	670	250	670	261	227	1140
3	2320		710	22.6	+.3	5600	7020	90	1247	68	217	581	585	180	581	695	210	699	279	699	287	237	1172
4	0240		735	21.8	+.6	5800	7200	65	1222	102	280	740	741	⊖	735	830	220	835	289	832	297	282	1149
5	0624		730	22.3	+.4	5670	6900	50	1193	52	280	851	851	260	852	898	320	899	312	898	322	306	1185
6	1055		730	21.0	+1.5	5980	7680	58	1175	62	191	537	535	136	536	653	150	655	231	656	231	207	1111
7	1330		720	21.6	+2.0	5860	6720	60	1160	60	210	520	521	140	521	674	186	672	269	671	275	225	1155
8	1555		730	22.4	+1.7	5680	7360	69	1310	70	231	589	590	157	590	690	184	690	280	690	290	243	1193
9	1834		730	22.5	+1.3	5640	6420	70	1100	55	215	558	559	152	555	720	183	721	262	720	276	237	⊖
10	2110		750	22.1	+1.3	5960	7260	79	1353	59	299	890	890	287	890	915	314	918	331	916	340	309	1190
11	0215		770	20.5	+2.9	5990	7200	70	⊖	60	215	491	492	140	492	727	159	726	235	728	249	221	1259
12	0523		770	20.9	+4.1	6050	7200	72	1260	58	209	513	513	140	513	692	149	698	222	698	228	218	1218
13	0825		760	20.5	+5.7	6100	7320	⊖	⊖	63	212	⊖	⊖	140	510	713	152	715	238	714	250	221	1155
14	1100		740	21.7	+6.1	5780	6600	⊖	1210	63	220	490	500	142	500	722	165	718	183	720	200	230	1255
15	1430		730	20.0	+8.2	6300	6360	80	1224	70	286	839	839	300	839	905	309	906	315	906	325	320	1280
16	1706		700	21.4	+8.9	5860	6720	83	1207	71	240	532	535	157	534	757	176	758	253	757	265	250	1225
17	2008		700	22.5	+8.5	5600	6780	80	1220	62	226	535	540	144	551	748	170	748	263	748	275	238	1170
18	2354		700	22.8	+7.8	5500	6580	84	1257	65	220	532	532	142	534	720	168	720	260	720	280	236	1220

REMARKS ⊖ Thermocouple out.
#4 - False Axle #6 - Pressure Plate #8 - Pressure Plate #10 - Pressure Plate
#5 - Torque Plate #7 - Fuse Plug #9 - Tube Well #11 - Bead Seat
#12 - Fluid #13 - #2 Rotor

EP355

Representative CONABLE. At the time you resigned from Goodrich, what was transpiring with respect to this brake? Apparently it had failed in the actual tests that were being made, the flight tests, rather than the laboratory tests; is that right?

Do you know what was transpiring with respect to the brake then?

Mr. VANDIVIER. During the flight tests; no, sir.

Representative CONABLE. Do you know if anything was going on with respect to the development of another brake?

Mr. VANDIVIER. There had been mention of scrapping the four-rotor brake and developing a five-rotor brake. Whether or not it was in progress at that time I do not know.

Representative CONABLE. You were not consulted and you would not have been consulted?

Mr. VANDIVIER. No; I would not have been consulted.

Representative CONABLE. In connection with this?

Mr. VANDIVIER. Not with that decision; no, sir.

Representative CONABLE. Do you know whether anything might have been going on in some other parts of the laboratory with respect to the development of a new suggestion? As far as you know your concern was the four-rotor brake?

Mr. VANDIVIER. In the laboratory; if there had been any development in the laboratory I would have known about it through the test data. I would have known about it through the test data. I would not flatly say there was nothing going on in regard to a five-rotor brake. I could only say that if there was, at this time I do not remember.

Representative CONABLE. Did you have any contact with Government inspectors during this period of time?

Mr. VANDIVIER. Only of routine day-to-day contact, speaking to them and all. They were not——

Representative CONABLE. Was the Government inspector involved in any way in the making of this report?

Mr. VANDIVIER. No, sir. The specification did not require Government inspection of the testing.

Representative CONABLE. Is this because it was between you and LTV at this point, between Goodrich and LTV or why?

Mr. VANDIVIER. I am not sure of the reason for this. I know that on some tests on some projects the C–5A, for instance, witnessing was required and the resident Air Force inspector witnessed most of the tests. On the A–7D this was not required. Why, I do not know.

Representative CONABLE. You make no allegation that a Government inspector was somehow involved in this falsification?

Mr. VANDIVIER. The only observation I would make is that he would not be involved. I am sure that he would have nothing to do with—I know the man, and his reputation is beyond question.

Representative CONABLE. And so the only people apparently involved in the falsification that you are alleging here would have been Goodrich people?

Mr. VANDIVIER. That is correct.

Representative CONABLE. There would have been no crossing of company lines on it. It would have been an internal matter as far as you know?

Mr. VANDIVIER. As far as I know, yes.

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Representative CONABLE. Do you know from whence the orders emanated originally to falsify this data? Do you know who was actually making the statements that you hve reported here, but you do not know where the orders came from?

Mr. VANDIVIER. I do not know, no. I only know what I was told. I know that I had discussed this with Mr. Line who was not my immediate supervisor but one of my supervisors and asked him if he was aware of what was going on, and he said he was aware, and I asked him, as I have said in my statement here, if he did not think that this was a rather foolish thing to do. And one thing I did not mention in my statement—I was concerned that I did not think we were doing the Goodrich Co. justice by allowing this thing to go on, and without their knowledge, because I knew that the people in Akron would not dare risk their reputation on such a project.

Representative CONABLE. What is your employment now, sir?

Mr. VANDIVIER. I work for the Troy News. I am a staff writer.

Representative CONABLE. For a newspaper?

Mr. VANDIVIER. Yes.

Representative CONABLE. Were you working for a newspaper at the time?

Mr. VANDIVIER. I worked part time for approximately 3 years. I wrote a column three times a week.

Representative CONABLE. I see. And you went right from the Goodrich Co. to the newspaper?

Mr. VANDIVIER. Yes. When I began writing for the newspaper approximately 3 years, I had a standing offer to go to work for them at any time.

Representative CONABLE. That is all I have at this point. Mr. Chairman.

Chairman PROXMIRE. I would like to follow up, Mr. Vandivier. I was asking—let me ask this. Did you ever object to the project manager of the aircraft wheel and brake design section, Robert L. Sink, about what Goodrich was doing on the A-7 brake report that was unethical?

Mr. VANDIVIER. Yes. At our meeting just prior to the meeting with LTV, this was a day-long Saturday meeting, and I questioned Mr. Sink repeatedly about what we were doing, and I asked him how we could present anything to LTV without adding that we had been lying in the beginning.

Mr. Sink seemed to think that all we had to do was to make a clean breast of everything, and this would be sufficient, and I suggested that before you can tell the truth, you must first admit that you had lied, and Mr. Sink became extremely angry and I shut up. We went to lunch and after lunch he called me to his desk and said he apologized for losing his temper earlier that morning, and he said he did not see the situation as one in which we were lying. He said we were—his words were that we were exercising "engineering license," and frankly I do not know what he means by engineering license.

I know what literary license is. I do not know what engineering license means.

Chairman PROXMIRE. I understand when engineering license is taken it loses engineering license. Why did you finally agree to take part in writing the false qualification report that you have described for the A-7D brakes?

Mr. VANDIVIER. Mr. Chairman, that is a question I have asked myself many times, and I can give you three reasons. I have seven children; I have a lot of bills; and I only have a high school education. That is the only excuse I can offer you.

Chairman PROXMIRE. In your statement you say:

He also said that the latest instructions he had received were to the effect that if the data from this latest test turned out worse than test T-1867 that we would write our report based on T-1867.

That was said by whom?

Mr. VANDIVIER. I believe this was said by Mr. Lawson who was passing along that we would either write the final report from the 13th qualification attempt or the 14th qualification attempt, whichever was the best. No. 13 was the one that had the 3-mile RTO, and the torque values on this test were so low that this was an impossible brake. We had no choice, if they were going to write a report. We had to do it on the next attempt, and Mr. Lawison said that we would wait and see what the data was going to look like and then we would make our decision in order to write the test from the 13th attempt or the 14th attempt.

Chairman PROXMIRE. Who changed the brakes stop time to which you have referred in your statement? Did you change that or was that changed by somebody else?

Mr. VANDIVIER. No, sir, I did not.

Chairman PROXMIRE. You said "The actual stopping time was 141 seconds" and then it was changed to 47—46.8 seconds.

Mr. VANDIVIER. Mr. Chairman, the only thing I can say in regard to that is that I have here a copy of a note, a handwritten statement dated the 15th of April, 1968 signed by Mr. R. L. Sink. It is headed "The A-7D," the No. 1 statement on this "complete the dynamometer load log for RTO. Use RTO stop time from service stops plus 1 second. The stop times on the overload stops need correction."

I do not know who this was submitted to. It was signed by Mr. Sink.

Chairman PROXMIRE. I would like to ask you did you at any time make any charges whatsoever against the five-rotor brake?

Mr. VANDIVIER. No, sir, that was developed after I left.

Chairman PROXMIRE. It is my understanding the five-rotor brake is a good brake. I have said that. I understand that this is a brake that is now in use on aircraft. As far as I know, there is no question about this brake whatsoever. I want to make that absolutely clear, because I think there has been some confusion between the five-rotor brake which I understand is a good brake, a workable brake, it is not being challenged by anybody, it is accepted, it is in use. But it is the four-rotor brake which is the one that you have been discussing this morning?

Mr. VANDIVIER. Yes, everything I have said here is concerned with the 2-1162-3 brake which is the four-rotor brake.

Chairman PROXMIRE. Very good. All right, now Mr. Lawson, will tell us again, please, what your job responsibilities were with Goodrich and how long you were employed with them?

Mr. LAWSON. I started employment with B. F. Goodrich on January 16, 1967, and I was hired in as a project engineer, and my job duties were detail design of projects that were turned over to me from the proposal engineer.

Chairman PROXMIRE. And you worked for how long, until what date?

Mr. LAWSON. Until October 25, 1968, so about 22 months, 21.
Chairman PROXMIRE. Approximately a little less than 2 years?
Mr. LAWSON. Yes.

Chairman PROXMIRE. When did you first become aware that there was a basic design fault in the four-rotor braking?

Mr. LAWSON. I believe I became aware if it after the—I would say two or three qualification attempts, which would be in December of 1967 in that area.

Chairman PROXMIRE. What was this basic fault?

Mr. LAWSON. The brake would not make the required number of stops as far as life of the brake. It just would not make it.

Chairman PROXMIRE. Did you inform your superiors of this fault?

Mr. LAWSON. Yes, I did.

Chairman PROXMIRE. What was their response?

Mr. LAWSON. Well, I was told—I wanted to change the design. That was my original request to them, to put more weight into the brake, and I was flatly refused by Mr. Warren. He said we would not put more weight in the brake.

Chairman PROXMIRE. Flatly refused by whom?

Mr. LAWSON. Mr. John Warren, and that we would not put any more weight into the brake. It was going to remain as is and we were going to qualify it.

Chairman PROXMIRE. Did either Mr. Sink or Mr. Van Horn ever tell you prior to the final qualification tests now what Mr. Vandivier told us "Regardless of what the brake does on the test we are going to qualify it."?

Mr. LAWSON. Yes, sir.

Chairman PROXMIRE. Who told you that?

Mr. LAWSON. Mr. Van Horn was the man who actually said the words.

Chairman PROXMIRE. Mr. Van Horn said that?

Mr. LAWSON. And Mr. Sink was at the meeting at the time. There were just the three of us.

Chairman PROXMIRE. What was his job responsibility or position with Goodrich?

Mr. LAWSON. Mr. Van Horn?

Chairman PROXMIRE. Yes.

Mr. LAWSON. He was the project manager. He was in charge of proposals and items like that.

Chairman PROXMIRE. He was your superior?

Mr. LAWSON. Yes, sir.

Chairman PROXMIRE. What was your reaction to that statement?

Mr. LAWSON. I don't know. I guess I was just dumbfounded. I did not say anything except OK.

Chairman PROXMIRE. Didn't it shock you that after all he is telling you that even if the brake does not meet the tests we are going to say it does, isn't that correct?

Mr. LAWSON. That is correct. I don't know. I guess I had no recourse. I just accepted it.

Chairman PROXMIRE. Your recourse was to resign immediately?

Mr. LAWSON. Yes.

Chairman PROXMIRE. Or take it to a higher authority. Could you have taken it to somebody else above Mr. Van Horn?

Mr. LAWSON. I really didn't feel there was anybody above him that I could take it to.

Chairman PROXMIRE. Did you assist in the preparation of Q–6031—the Goodrich report under discussion here today—and did that report contain numerous false statements?

Mr. LAWSON. There were numerous erroneous statements in there. I would not use the word false. I do not know under what test they were telling me to do this, I do not know what motivations they had but there are changed statements in that qualifications report.

Chairman PROXMIRE. Changed statements you say?

Mr. LAWSON. Yes.

Chairman PROXMIRE. How do you know they were changed?

Mr. LAWSON. Because I changed them.

Chairman PROXMIRE. You changed them. And you did this on the basis of being told to qualify the brake?

Mr. LAWSON. That is correct, sir.

Chairman PROXMIRE. Regardless of the situation. In order to do that you thought you had to change those statements?

Mr. LAWSON. Well, I did not think I had to change them. I was told to change them.

Chairman PROXMIRE. I understand that these brakes, these 4-rotor brakes which we are discussing now—who told you to change the test data in the report?

Mr. LAWSON. Mr. Robert Sink.

Chairman PROXMIRE. Mr. Robert Sink told you to change them?

Mr. LAWSON. That is correct, sir.

Chairman PROXMIRE. I understand that these 4-rotor brakes we have been discussing were passed along to Ling-Temco-Vaught, LTV, and were actually tested in an aircraft?

Mr. LAWSON. That is correct.

Chairman PROXMIRE. At Edwards Air Force Base?

Mr. LAWSON. Right. They were tested on a flight test airplane.

Chairman PROXMIRE. It seems to me that on the basis of the testimony that you and Mr. Vandivier gave us, this was extraordinarily dangerous to the pilot involved. He could have been killed. The aircraft could have been destroyed, isn't that correct, or is it correct?

Mr. LAWSON. I don't think it was as dangerous as I originally had thought it might be.

Chairman PROXMIRE. What is that?

Mr. LAWSON. I don't think it was as dangerous as I had originally thought, as I became more familiar with the testing procedures and the safety precautions that they do have at the military test facilities, I realized it wasn't as dangerous as I thought, but I still believed it was a dangerous situation.

Chairman PROXMIRE. How about the danger of fire? Isn't this a real danger?

Mr. LAWSON. Well, it is present. The brakes can weld up.

Chairman PROXMIRE. It could have happened?

Mr. LAWSON. Well, yes, it could have happened.

Chairman PROXMIRE. What actually did happen when these brakes were tested? You said you were there.

Mr. LAWSON. Yes, I was there.

Chairman PROXMIRE. How did the brake perform when the brakes were used?

Mr. LAWSON. I don't know the exact number of occasions, but the lining surfaces of the brake did stick together and the airplane slid to a stop on occasions and the brakes had to be pried apart with a screwdriver to get it to roll again.

Chairman PROXMIRE. Describe as accurately as you can exactly what the brake did when the plane came in and the brakes were used?

Mr. LAWSON. It would be landing under normal return from flight, and the pilot would touch down. They were doing brake tests, and he would apply the brakes at a certain velocity that was prescribed in the manuals, and they would be doing a normal braking roll and the brakes would lock up.

Chairman PROXMIRE. The brakes would lock?

Mr. LAWSON. Yes. Well, they would stick together.

Chairman PROXMIRE. The plane would skid?

Mr. LAWSON. Yes, and it would just slide.

Chairman PROXMIRE. The possibility under these circumstances heat would be generated within the brake which might cause a fire?

Mr. LAWSON. Well, not after they stopped rotating, but while they were rotating heat was being generated.

Chairman PROXMIRE. This was a possibility?

Mr. LAWSON. Yes.

Chairman PROXMIRE. How fast would the plane be traveling coming in?

Mr. LAWSON. The speed varies with the weight.

Chairman PROXMIRE. GAO, in response to our question investigating the brake—we asked them to go ahead and investigate this discussion—stated in their report (see appendix) and I read on page 10, "In response to question regarding pilot safety and structural damage Federal Aviation Administration officials stated warping or welding of the brakes would blow out the tire which in turn might cause collapsing of the landing gear" No. 1.

2. Breaking of the hydraulic lines and/or puncturing of the gas tanks located in the aircraft wing.

As a result they further stated the most likely danger was a fire due to the combination of the heat in the brakes and leaking hydraulic fluid and/or jet fuel.

They also told us, however, they did not have any accident investigating reports concerning such instances.

On the basis of your expert knowledge and the fact that you were there at the time, were you concerned that this would be the situation?

Mr. LAWSON. Originally I was.

Chairman PROXMIRE. As a danger?

Mr. LAWSON. That is correct.

Chairman PROXMIRE. Why did you make the statement you made to the FBI?

Mr. LAWSON. I believe my really feeling for going to the FBI was one of just, I guess, protecting myself. I realized from speaking with Mr. Warren, who had made statements to me to the effect that whenever something gets in trouble, referring to being at the Goodrich plant, you were on your own, don't look for your supervisors to be around, and from seeing experiences, experiencing things at Goodrich, where Mr. Sink had been involved in another incident, and somebody else was demoted, and other items like that, that I felt that I needed to talk to somebody about it, because it was a pretty serious situation, and the only person I could think of was to consult an attorney, and then he advised me to talk to the FBI.

Chairman PROXMIRE. What did you say in your statement to the FBI?

Mr. LAWSON. I told them about the items in the testing procedures, what had gone on.

Chairman PROXMIRE. Can you provide the committee with a copy of your statement?

Mr. LAWSON. To the FBI?

Chairman PROXMIRE. Yes.

Mr. LAWSON. I really couldn't because I just gave it to them verbally and I did not record it. They must have a record.

Chairman PROXMIRE. Were any Government inspectors or employees involved in the testing of the brakes?

Mr. LAWSON. No, they were not.

Chairman PROXMIRE. At any time?

Mr. LAWSON. Not to my knowledge.

Chairman PROXMIRE. There were not present when the brakes were tested?

Mr. LAWSON. There was not a requirement for them to be present on this test.

Chairman PROXMIRE. How about LTV employees, were they present when these brakes were tested?

Mr. LAWSON. On some of the preliminary tests, yes.

Chairman PROXMIRE. They were there at some times and not there at other times. They were not there during the final testing?

Mr. LAWSON. That is correct. They were not there for the final test.

Chairman PROXMIRE. You say they were there for some of the preliminary tests?

Mr. LAWSON. Yes.

Chairman PROXMIRE. Wouldn't their presence protect against some of the things that you have described? Why wouldn't they have noticed the fact that these brakes were defective?

Mr. LAWSON. Why wouldn't they notice?

Chairman PROXMIRE. Were these preliminary tests so limited that they wouldn't indicate the brake's qualifications?

Mr. LAWSON. I am trying to recall right now, Senator, what were some of the explanations we gave, because the original tests were prototype tests on hardware that was put together to evaluate the parameters that Mr. Warren had set up for the A7D brake and I do not really recall the exact explanations that were given according to the testing.

Chairman PROXMIRE. At any rate the procedure was that Goodrich was the representative on the production of the brakes at times and when the preliminary tests were made LTV had some representation there?

Mr. LAWSON. That is correct.

Chairman PROXMIRE. But there was never any Air Force representation on the four-rotor brake?

Mr. LAWSON. I don't remember any Air Force personnel being present for the testing.

Chairman PROXMIRE. It was put into the plane at Edwards Air Force Base and tested under the conditions that you have described to us this morning?

Mr. LAWSON. No, I don't remember any Air Force people being there.

Chairman PROXMIRE. Congressman Conable?

Representative CONABLE. Mr. Lawson, what were the circumstances of your separation from employment by B.F. Goodrich? I notice that you terminated your employment there the same day that Mr. Vandivier did.

Mr. LAWSON. I turned in my resignation before Mr. Vandivier.

Representative CONABLE. You turned in your resignation before that?

Mr. LAWSON. Yes.

Representative CONABLE. I notice that you are now employed by the general contractor in this case.

Mr. LAWSON. That is correct.

Representative CONABLE. By LTV. Did you have any discussion with LTV before you terminated employment there?

Mr. LAWSON. No, I did not, sir.

Representative CONABLE. And there is not any connection between your employment by LTV and your having been involved in this particular brake affair?

Mr. LAWSON. No, there is not. I just wanted to get back into the aerospace industry, and I turned in an application to them and they accepted and I just went to work there.

Representative CONABLE. Do you know if anybody discussed with representatives of LTV the qualification report on the 4-rotor brake, if there had been any discussion of problems with the brake or anything of that sort?

Mr. LAWSON. There probably was. I cannot answer the question, sir. I really am not that well informed.

Representative CONABLE. Mr. Vandivier, do you know if there was any discussion with LTV?

Mr. VANDIVIER. None that I know of.

Representative CONABLE. I am confused. I do not see what Goodrich would have had to gain by falsifying the qualification report on the 4-rotor brake. What does a favorable qualification report indicate? Perhaps that will clear up something for me. Does it indicate that the laboratory tests showed that the thing may work on flight testing or what does it prove?

Mr. LAWSON. Are you directing that question to me?

Representative CONABLE. Yes, I am asking you as an engineer.

Mr. LAWSON. What the qualification report has to contain?

Representative CONABLE. What it indicates. Does it indicate anything besides the fact that certain tests were made?

Mr. LAWSON. It indicates—that is correct, it indicates that the brake has met the requirements of the procurement "spaces" of both the Government and the contractor.

Representative CONABLE. It means that it is qualified to be used on a production aircraft, does it, or does it mean simply that it is qualified to be flight tested?

Mr. LAWSON. It is qualified to be flight tested. It was flight tested first before it went on any production airplanes.

Representative CONABLE. Mr. Vandivier said in his statement that flight tests of the brake were begun after the qualification report was issued. The GAO said that flight tests of A–7D were conducted prior to LTV's approval of the qualification report. Is that a usual practice?

Mr. LAWSON. I do not know the real sequence of it.

Representative CONABLE. Do you know if sometimes they do flight-test something before the qualification report has been approved?

Mr. LAWSON. There would be no reason why you could not use a piece of equipment on flight test before the qualification report was approved as long as there was——

Representative CONABLE. The problem would be that there would be greater risk involved if you did not complete the qualification report first, is that it, or why would they have a qualification report if you are going to go ahead and flight-test it anyway?

Mr. LAWSON. I believe I really don't know that.

Representative CONABLE. Is it your understanding that LTV did not flight test the brakes until after it accepted the qualification report? Maybe we should clear that up with the GAO, but do you have any knowledge of the sequence? You were there at Edwards Air Force Base when it was flight tested. Do you know what the status of the qualification report was at that time?

Mr. LAWSON. I know the qualification report had been submitted before the flight testing at Edwards.

Representative CONABLE. It had been submitted but you did not know whether it had been approved or not?

Mr. LAWSON. No, I did not know whether it had been approved.

Representative CONABLE. Did Goodrich as a corporation have anything to gain by deviating from testing procedures and falsifying test data?

Mr. LAWSON. I really don't know.

Representative CONABLE. In fact, problems with the brake were discovered in the normal procedures that are followed in such cases?

Mr. LAWSON. That is correct.

Representative CONABLE. And Goodrich did have to make good on a piece of equipment that they had contracted to furnish?

Mr. LAWSON. That is also correct.

Representative CONABLE. I am just confused about what they would gain from falsifying this data.

Mr. LAWSON. Frankly, so am I.

Representative CONABLE. Is it your opinion that this is more a matter of personal internal programs, personnel internal problems of the Goodrich Co., or do you think this is a result of some company policy to try to——

Mr. LAWSON. I don't believe it was company policy. I believe your original statement was probably more correct. It was a matter of pride of certain individuals who were involved.

Representative CONABLE. In the 2 years——

Chairman PROXMIRE. Will the Congressman yield at that point? I agree wholeheartedly and I think Mr. Vandivier does too. So far as we know, and I think there is every reason to suspect this is true, the Goodrich top management and other officials are blameless on this.

They did not know about it. It was somewhere along the line that somebody had this pride.

Representative CONABLE. In the 2 years that you worked for Goodrich were you aware of any other incidents similar to this?

Mr. LAWSON. No, I was not.

Representative CONABLE. That is all I have at this time, Mr. Chairman.

Chairman PROXMIRE. I just have—I would like you to give us advance word on this. Goodrich has the last word here and they should have. They are the last witnesses, but in the prepared statement made, to be made to us by Goodrich, there are three statements I would like to ask your judgment on, Mr. Lawson. One is on page 2, where Mr. Jeter says:

> It was the judgment of the responsible B. F. Goodrich aircraft brake engineers that the 4-rotor brakes satisfactorily performed the indoor tests and was ready for field testing on the A–7D.

Now, apparently—you are an engineer?

Mr. LAWSON. Yes, sir.

Chairman PROXMIRE. You disagreed with that and you told your superior you thought these brakes would not qualify, is that correct?

Mr. LAWSON. That is correct.

Chairman PROXMIRE. Do you know anybody else who is qualified or would be in a position to know, any other engineer who knew about this who would contradict your position?

Mr. LAWSON. Contradict my position, you say?

Chairman PROXMIRE. Yes, in saying that these brakes were qualified, were ready for field testing.

Mr. LAWSON. I know they said it then, Mr. Warren did, but I don't know if he would say it on the witness stand or not.

Chairman PROXMIRE. You what?

Mr. LAWSON. I don't know if he would say it here. I know at the time——

Chairman PROXMIRE. You had the direct responsibility. You were the engineer responsible in this area, is that correct, Mr. Lawson?

Mr. LAWSON. That is correct.

Chairman PROXMIRE. And you were the one who worked on the brakes, is that correct?

Mr. LAWSON. That is correct.

Chairman PROXMIRE. Let me ask you this then. Further on page 2 he said:

> It has never been determined whether the knitting problem resulted from the brake design or because of an incompatibility between the brakes and its associated parts of the braking system.

I take it your testimony to us was that the brake needed more weight?

Mr. LAWSON. That is correct. I felt that way.

Chairman PROXMIRE. Would you contradict, then, this assertion made by Goodrich—let me read that again:

> It has never been determined whether the knitting problem resulted from the brake design or because of an incompatibility between the brakes and its associated parts of the braking system.

Mr. LAWSON. I would disagree with that statement.

Chairman PROXMIRE. All right. Finally let me ask you this. What is your opinion on this?

Mr. LAWSON. As I originally stated, the brake had a lining material in it which was of a low fusion level, and on the overload energy stops there was enough heat generated to weld the surfaces together.

Chairman PROXMIRE. And then finally also on page 3 of Mr. Jeter's statement it is stated:

> It is most significant that the four-rotor brake knitting problem referred to above could not have been predicted from the indoor laboratory tests which the contract required regardless of how precisely these tests may have been performed. The knitting problem was the only significant field problem with the four-rotor brake.

Mr. LAWSON. I disagree with that statement.

Chairman PROXMIRE. You disagree. You think it could have been predicted and you, in fact, told your superior that this brake would not work?

Mr. LAWSON. That is correct.

Chairman PROXMIRE. On the basis of the indoor laboratory tests?

Mr. LAWSON. That is correct.

Chairman PROXMIRE. Did anybody else make tests besides you on this brake?

Mr. LAWSON. No, I do not believe they did.

Chairman PROXMIRE. You were the engineer working on this brake?

Mr. LAWSON. That is correct.

Chairman PROXMIRE. Thank you.

Representative CONABLE. One last question.

Mr. Lawson, there are Government inspectors around the Goodrich plant, are there not, when they are working on a contract of this sort, and I suppose they are there primarily to check specifications, is that correct?

Mr. LAWSON. That is correct.

Representative CONABLE. Do you know of anybody having had any contacts with the Government inspector about this problem during this period of time?

Mr. LAWSON. As I understand it, the Government inspector at the plant only witnesses the tests when he has paperwork that requires him to witness them. I believe the Government inspector did not have such paperwork and he did not witness any of these tests in this case.

Representative CONABLE. Why did he not have such paperwork in this particular case, since it was eventually for the benefit of the Government that the work was being done?

Mr. LAWSON. I do not know.

Representative CONABLE. Was it because at this stage in the process it was something between LTV and Goodrich?

Mr. LAWSON. I do not know. Other times there are Government inspectors on contract in Goodrich brake qualifications.

Representative CONABLE. Suppose someone had complained to the Government inspector at this point. Would he have taken any jurisdiction of problems relating to the laboratory tests?

Mr. LAWSON. I assume he would have.

Representative CONABLE. You assume he would have?

Mr. LAWSON. Yes.

Representative CONABLE. But nobody did?

Mr. LAWSON. No, not to my knowledge.

Representative CONABLE. So that there was some other authority you could have appealed to other than the project manager had you wished to at that time?

Mr. LAWSON. I suppose you are correct. I did not think of him at the time, to be truthful with you, because I never really had any contact with the gentleman.

Representative CONABLE. All right, that is all, Mr. Chairman.

Chairman PROXMIRE. Gentlemen, I want to thank you very, very much. Incidentally, Mr. Lawson did go to the FBI. He did appeal in that way.

Mr. LAWSON. That is correct.

Chairman PROXMIRE. I want to thank you gentlemen very much for this testimony. I think it takes extraordinary courage to do what you have done. You were in a difficult position and you have agreed perhaps that if you had it to do over again you would have acted more expeditiously, but the fact that you did go to the Federal Bureau of Investigation, you did resign, you did suffer an economic risk and loss through this incident, I think is to your great credit, and I very much appreciate your testimony to us today. Thank you very much.

Mr. LAWSON. Thank you, sir.

Chairman PROXMIRE. Our next witnesses are from the Air Force. Mr. Robert L. Hartman, chief systems Engineer, Headquarters, Aeronautical Systems Division, Wright Patterson, and Mr. Bruce Tremblay, Headquarters, Aeronautical Systems Division, AFSC, Wright Patterson Air Force Base.

Gentlemen, do you have a statement?

STATEMENTS OF ROBERT L. HARTMAN, CHIEF SYSTEMS ENGINEER, AND BRUCE TREMBLAY, HEADQUARTERS, AERONAUTICAL SYSTEMS DIVISION (AFSC), WRIGHT PATTERSON AIR FORCE BASE

Mr. HARTMAN. Mr. Chairman, we do not have a statement as such. We do have some background information which refers to our qualifications and our role in the development of A–7D airplane and qualification of the brake.

Chairman PROXMIRE. This is very brief. The qualifications will be printed in the record.

Why don't you go right ahead and read this short page on your present position responsibility as to component qualifications.

(The background information of both witnesses follows:)

BACKGROUND INFORMATION ON MR. TREMBLAY, SYSTEMS GROUP LEADER FOR LANDING GEAR IN AIRFRAME SUBSYSTEM DIRECTORATE, AERONAUTICAL SYSTEMS DIVISION, AIR FORCE SYSTEMS COMMAND

NAME: David B. Tremblay.

TITLE: Systems Group Leader for Landing Gear in Airframe Subsystem Directorate, Aeronautical Systems Division.

QUALIFICATIONS: BME University of Dayton 1950; MBA Ohio State University 1969; Professional Engineering License, State of Ohio, #22661.

Major Assignments—

—5 years automotive equipment test engineer;

—Approximately 4 years Air Force landing gear project engineer, particular specialty of wheels and brakes;

—1½ years—Group Leader Aircraft Wheel and Brake R&D, Bendix Products Division of Bendix Corp. in South Bend, Indiana;

—5 years Air Force landing gear subsystem engineer on C–141A and F–111; and

—3½ years Systems Group Leader for Landing Gear in Airframe Subsystem Directorate of Aeronautical Systems Division. Exercise technical cognizance of all systems under development with specific responsibility for A–7D.

A–7D RESPONSIBILITIES:

I am responsible for technical review of A–7D landing gear equipment. I recommend approval or disapproval of Ling Temco Vought equipment specifications, proposed test procedures and resulting test reports to the Aeronautical Systems Division A–7D Systems Engineer. These recommendations are based upon comparison with military specification technical requirements and experience obtained on other development programs. On the A–7D, this level of review was exercised on the anti-skid brake control system, wheels, brakes and tires. These items are A–7D peculiar and have been developed specifically for this application.

BACKGROUND INFORMATION ON MR. HARTMAN, CHIEF SYSTEM ENGINEER, A–7D AIRPLANE, AERONAUTICAL SYSTEMS DIVISION, AIR FORCE SYSTEMS COMMAND

NAME: Robert L. Hartman.

TITLE: Chief System Engineer, A–7D Airplane.

QUALIFICATIONS: BSME Purdue University 1950; Employed at WPAFB 1954–Present;

Major Assignments—

1954–1959—Development Engineer, Propulsion Laboratory, for Fuel System and Mechanical Equipment;

1959–1961—Senior Development Engineer, Rocket Propulsion Laboratory Field Engineering Office, for Solid Rocket Motor Development;

1961–1963—Asst Chief Airframe and Propulsion Division GAM–87A Engineer-Office. Responsible for engineering development of airframe and propulsion ing Office. Responsible for engineering development of airframe and propulsion system;

1963–1966—Chief Engineer, Systems Engineering Directorate, Responsible for providing technical guidance and engineering direction to the F–104 G airplane and GAM–77 (Hounddog) missile program offices; and

1966–Present—Chief Systems Engineer, Systems Engineering Division. Responsible for providing engineering guidance and technical direction to the A–7D airplane program office.

PRESENT POSITION RESPONSIBILITIES

As the Chief Systems Engineer, I provide engineering and technical support to the A–7D Program Management Office (PMO) located in the Main Navy Building, Washington, D.C. This office is a joint Navy/Air Force program management office.

As the Chief System Engineer, I determine the level of technical review required, the tehcnical disciplines necessary to accomplish the review, assign the tasks and establish the priorities.

The engineering support provided involves technical review and recommended action on all engineering data necessary to develop the A–7D airplane. This includes specifications, test programs, test reports, engineering inspections and reviews.

COMPONENT QUALIFICATION RESPONSIBILITIES

As the Chief System Engineer, I provide assurance that the procurement specifications contain sufficient and valid requirements for use on the weapon system. I assure that the testing accomplished verifies compliance to the procurement specification reqiurements. I monitor the flight testing of the component and evaluate this testing as evidence of compliance or noncompliance to the airplane requirements. I provide recommendations to the Program Management Office relative to the qualification staus of the component under evaluation and recommend appropriate action.

Mr. HARTMAN. I am chief systems engineer for the A7D Air Force airplane. As the chief systems engineer I provide engineering and technical support to the A7D program management office located in the main navy building, Washington, D.C. This office is a joint Navy-Air Force program management office.

As the chief systems engineer I determine the level of technical review required, the technical disciplines necessary to accomplish the review, assign the tasks and establish the priorities. The engineering support provided involves technical review and recommended action on all engineering data necessary to develop the A7D airplane. This includes specifications, test programs, test reports, engineering inspection and review.

With respect to component qualification responsibility as the chief systems engineer I provide assurance that the procurement specification contains sufficient and valid requirements for use on the weapons system.

I assure that the testing accomplished verifies compliance to the procurement specification requirements, and I monitor the flight testing components and evaluate this testing as evidence of compliance or noncompliance to the airplane requirements.

I provide recommendations to the program management office relative to the qualification status of the component under evaluation for appropriate action.

Chairman PROXMIRE. All right, sir.

Mr. Tremblay, do you have anything to add?

Mr. TREMBLAY. My job is landing gear systems engineer and my responsibility is to review specifications, test procedures, and qualification tests on landing gear equipment associated with A7D and other systems in the Air Force.

Chairman PROXMIRE. According to Mil-W-5013G the specifications governing the brakes used for qualification tests, the brake which is used for qualification tests is supposed to be identical, it has to be, in the production of the brake. In your opinion, judging from the testimony you have heard this morning, and from the photograph which I take it is in front of you at the present time, which Mr. Vandivier had brought with him, and from information contained in the GAO report, was that B. F. Goodrich four-rotor brake qualified identical to brakes slated for production?

Mr. TREMBLAY. The brakes shown in the picture is not identical to the production brake that was delivered for the flight test program.

Chairman PROXMIRE. In what way does it differ?

Mr. TREMBLAY. It has two plates between the brake housing and the first rotating disk.

Chairman PROXMIRE. Do you want to comment, Mr. Hartman?

Mr. HARTMAN. No, I do not want to comment on this. I defer to his technical judgment.

Chairman PROXMIRE. Do you agree with him? Are you technically qualified to comment on that question?

Mr. HARTMAN. I do not believe I am qualified to comment on the detailed design of the braking system.

Chairman PROXMIRE. How would that part that had apparently been inserted in this test brake make a different production brake? Why, Mr. Tremblay, would that make a difference in testing? Can you explain that to us?

Mr. TREMBLAY. My technical judgment would be that if the lining had worn sufficiently, there was danger of the pistons exceeding their allowed travel in the housing. This would prevent that.

In other words, it would act as a spacer.

Chairman PROXMIRE. As I understand it, then, what this would do is to make it show up better in the wear and tear on the lining, is that correct?

Mr. TREMBLAY. No, sir.

Chairman PROXMIRE. All right, explain it to us again.

Mr. TREMBLAY. It would permit it to complete the stop without losing the piston from the housing.

Chairman PROXMIRE. What it would do is permit it to pass the test when otherwise it might not pass the test, is that right?

Mr. TREMBLAY. It depends on when it was inserted, sir. I do not believe I understand your question completely. You mean complete the one run involved or for the whole test program?

Chairman PROXMIRE. The one run involved.

Mr. TREMBLAY. In trying to recall Mr. Vandivier's testimony, he indicated that this brake was used in this configuration for the worn brake RTO. Worn brake RTO by instruction in the Mil Spec is for information only. The purpose of the test is to determine the mode of failure. It is known that the brake will fail during the conducting of this worn brake RTO.

Chairman PROXMIRE. Let me ask you this. We have heard this morning that during the qualification test B. F. Goodrich disassembled the brake being tested for qualification for the A7D and cleaned, machined and generally reworked the brake. Is this process permissible according to military specification and/or industry accepted practice during qualification tests?

Mr. TREMBLAY. No, sir; it is not.

Chairman PROXMIRE. It is not. And you think that kind of practice and test—would it make the test still valid?

Mr. TREMBLAY. No.

Chairman PROXMIRE. Or would it invalidate the test?

Mr. TREMBLAY. It would invalidate the test in my technical opinion.

Mr. HARTMAN. Excuse me, Mr. Chairman.

Chairman PROXMIRE. Yes, Mr. Hartman?

Mr. HARTMAN. The specification does not specifically address this particular subject but it is accepted practice that you not do this sort of thing.

Chairman PROXMIRE. At any rate your testimony as far as I am concerned as a layman is that by doing this in the testing while the test was going on, the test would not be worthwhile, would not be useful?

Mr. TREMBLAY. That is correct.

Chairman PROXMIRE. Now would you indicate whether this would also be true with production testing?

Mr. TREMBLAY. That is correct.

Chairman PROXMIRE. According to the GAO report under the section entitled "Test Procedures for the Four-Rotor Brake" we learned that B. F. Goodrich switched stator, or stationary parts during testing. An Air Force engineer who is unnamed in the report commented on this to the GAO and he said and I quote directly from the report: "The switching of parts was unacceptable."

In your opinion, Mr. Tremblay, was this switching of parts acceptable?

Mr. TREMBLAY. If parts were switched it would be unacceptable.

Chairman PROXMIRE. It would be unacceptable. And how would that affect the validity or the usefulness of the tests?

Mr. TREMBLAY. If the lining or if the brake were experiencing a localized wear condition, changing of the disk location and position in the stack would prevent the adverse wear from progressing any further, and would in fact give an average longer life to the brake.

Chairman PROXMIRE. Let me ask you this. We have heard testimony this morning that the lining material used on the brake for testing purposes was thicker and heavier than lining material used on production brakes. Is this permissible?

Mr. TREMBLAY. Absolutely not.

Chairman PROXMIRE. Absolutely not?

Mr. TREMBLAY. That is correct.

Chairman PROXMIRE. When you receive a qualification report for approval, for instance, the A7D qualification report, do you have any way of knowing whether or not that report is accurate in its documentation of the actual raw or test recorded data? Do you have access to the raw data so that you can check out the qualifications for yourself?

Mr. TREMBLAY. I requested that data.

Chairman PROXMIRE. Did you handle this particular brake?

Mr. TREMBLAY. Yes, sir.

Chairman PROXMIRE. What happened when you requested the data?

Mr. TREMBLAY. I was told that it was not available because it was proprietary.

Chairman PROXMIRE. You were not given this data in this instance?

Mr. TREMBLAY. No, sir; I was not.

Chairman PROXMIRE. Now let me ask you this question again. When you received the qualification report for approval, did you have any way of knowing whether or not that report is accurate in its documentation of the actual raw or test-recorded data when you do not have access to the data or when you have been refused access to the data as you were in this case?

Mr. TREMBLAY. In review of the test reports I do not have any way other than looking at the raw data.

Chairman PROXMIRE. And you were not given the raw data in this case so you have no other way in this case except relying on the report, is that correct?

Mr. TREMBLAY. But I did request it.

Chairman PROXMIRE. You did request it, I understand that.

Mr. TREMBLAY. Yes, sir.

Chairman PROXMIRE. And they said it was proprietary and you could not have it?

Mr. TREMBLAY. Yes, sir.

Chairman PROXMIRE. Does this happen often when you request data of this kind, you are not permitted to have the raw data on the grounds it is proprietary?

Mr. TREMBLAY. No, sir; it is not.

Chairman PROXMIRE. Why did you request it in this case? Were you suspicious?

Mr. TREMBLAY. No, sir. It is standard practice of mine when I review the qualification test report, to compare it with the raw data, because there is a requirement in the specification that the data be reported, and I wanted to see it and compare it.

Chairman PROXMIRE. How often are you denied the raw data? Do you usually get it when you ask for it?

Mr. TREMBLAY. I usually get it; yes, sir.

Chairman PROXMIRE. What did you do when you were denied that raw data in this case?

Mr. TREMBLAY. I wrote a letter to Mr. Hartman who in turn passed it to the A-7 program management office telling them that the qualification test report should be disapproved.

Chairman PROXMIRE. You recommended that it be disapproved?

Mr. TREMBLAY. Yes, sir.

Chairman PROXMIRE. Will you supply that letter for the record?

Mr. TREMBLAY. Yes, sir; I would be happy to.

(The letter follows:)

ASNNX—A-7D MAIN WHEEL BRAKE REPORT #Q-6031, DATED JUNE 5, 1968

AUGUST 26, 1968

Reference is made to the attached letter from ASNFL to ASNNX, dated 20 August 1968. This letter contains comments resulting from a technical review of the subject report. These comments identified numerous discrepancies in the report. In addition it should be noted that unsatisfactory performance is presently being experienced in the Cat I flight test program. It is, therefore, the recommendation of this office that approval of this report be withheld until the contractor satisfies the request for clarification and additional data made in the referenced letter and satisfactory performance is achieved in the flight testing.

ROBERT L. HARTMAN,
Chief System Engineer, Division of Systems Engrg. "A."

DEPARTMENT OF THE AIR FORCE,
HEADQUARTERS AERONAUTICAL SYSTEMS DIVISION (AFSC),
Wright-Patterson Air Force Base, Ohio, August 20, 1968.

Reply to Attn. of: ASNFL (Mr. Tremblay/55555/B16/P 1-106)
Subject: A-7D Main Wheel Brake Test Report
To: ASNNX (Mr. R. L. Hartman)

1. Reference is made to the following:

a. B. F. Goodrich Test Plan #273, Revision E, dated 16 May 68, submitted for review.

b. B. F. Goodrich Test Report #Q-6031 dated 5 Jun 68, submitted for review.

2. The referenced test plan appears to satisfy the requirements of LTV Specification #204-16-37d and MIL-W-5013G. However, there is inadequate detail for testing as evidenced by the referenced test report, which was submitted as being in compliance. Details are furnished below.

3. The referenced test report has been reviewed, and it is recommended that approval be withheld. The report contained no original test data, only replotted information. Samples of the oscillograph traces are needed for evaluation of vibration tendencies. The peak torque data are totally inadequate. The details on how the information was obtained is not presented nor is the method of selection for the data presented. Some assurance is needed that the runs selected are the most severe since the requirements are in terms of maximum allowable peak. The brake pressure associated with the peak torques is required to insure that even higher torques are not feasible within the aircraft pressure range.

4. The method of conducting the test was highly unconventional and without suitable explanation acceptable to this office. The Industry accepted method of dynamic torque testing is to intersperse overload energy stops with the normal energies rather than to conduct all of them at the conclusion of the normal energy sequence. From the report, it was impossible to determine if the lining material was changed after the 45 stop condition. The text on page 19 states that "The 45 normal energy stops shall be conducted on one set of friction material." This would not preclude changing for the 5 overload stops and the report does not indicate one way or the other. The test data indicate that none of the 5 overload

stops were conducted within the requirements of the LTV specification or MIL–W–5013G. All had excessive stop times, which implies inability to meet the required deceleration rates of 10 ft/sec/sec. These were conducted with brake pressures ranging from 900 psi to 965 psi and the maximum available pressure is 1000 psi. The deceleration rates range from 9.58 ft/sec/sec at stop #45 to 8.74 ft/sec/sec at stop #50. This occurs while increasing the brake pressure from 900 psi to 965 psi. It was also noted that a fuse plug blew during one of the overload energy stops, which is forbidden on all other Air Force applications because of the potential nuisance of premature activation in the field. Actually the overload energy is comparable to a normal energy stop plus only 2 x 10^6 ft lbs input during taxi into the ramp.

5. There appeared to be a discrepancy in the data presented for overload stop #4. The tubewell temperature in the wheel was reported to be 464° F and the fuse plug temperature was only 350° F. Since the fuse plug is mechanically attached to the tubewell, it is physically impossible to have a 114° F temperature differential. It was also noted that the brake housing temperature exceeded 350° F during the overload energy test. This is beyond the stability temperature of the fluid and seals during a condition which is supposed to impose no permanent damage.

6. There appeared to be a basic discontinuity in the data presented on the new brake RTO. The plot of temperatures was terminated 18 minutes beyond the start of test and the point of fuse plug relief was not shown. From the text, it was indicated that the fuse plug blew after 12 minutes but it did not give the point of reference. The cooling curves show continuous recording from the start of the conditioning stop but the actual rejected takeoff started at the point of 5 minutes. The point of 350° F occurred at the bead seat at 2.5 minutes after the start of the rejected takeoff but if the fuse plug action occurred after 12 minutes, there was a period of 9.5 minutes when the tire would be damaged to the point of potential failure until there was pressure release. This clearly indicates improper and inadequate fuse plug performance.

7. On the worn brake RTO, the peak torque reached a value of 15,500 ft lbs which exceeds the limit load for drag on the landing gear. A worn brake RTO is just as likely as a new brake RTO.

8. The report submitted an environmental test report on a C–5A brake for substantiation of the A–7D design. The C–5A uses beryllium brake or a steel brake, and it is not discussed which unit is being tested. No correlation was presented between the unit tested and the A–7D, therefore, the information has no validity.

9. In LTV Specification 204–16–37d, paragraph 3.16, the reliability requirement is for 1000 MTBF. The Goodrich analysis indicates a MCBF of 785 landings and assumes a 2 hour mission time to produce a 1570 MTBF. The assumption of 2 hours mission time is questioned.

10. The data submitted for review did not include a wheel test report. Since the assemblies are tested at the same time and the interface is so vital, it is mandatory for the wheel test report to be reviewed before any final disposition of the brake assembly.

11. In accordance with paragraph 4.5.18 of MIL–W–5013G, the right is reserved to require service tests on equipment before any approval is granted. In view of the poor performance to date on the A–7D during Cat I flight test, withholding of approval is recommended.

12. In view of the many items enumerated above, it is not understood how LTV could have granted approval of B F Goodrich. The Contractor should be instructed to rescind any approval previously granted.

WM. A. HAMILTON,
Chief, Landing Gear & Mechanical Equipment Div., Directorate of Airframe Subsystems Engineering.

Chairman PROXMIRE. Mr. Hartman, do you recall receiving that letter from Mr. Tremblay?

Mr. HARTMAN. Yes, sir. We received the letter and I forwarded a letter to the Program Management Office identifying the reasons that we were not accepting the report.

Chairman PROXMIRE. What were the reasons?

Mr. HARTMAN. The major reasons were that there were some areas in the report that technically were difficult to understand, and in addition some of the test data submitted did not meet the requirements. I would like to defer to Mr. Tremblay if you want more specifics on this kind of discussion.

Chairman PROXMIRE. What happened when this report was not accepted? At what point was this refusal to accept the report made?

Mr. HARTMAN. My letter?

Chairman PROXMIRE. Was it after the testing at the Edwards Air Force Base?

Mr. HARTMAN. Yes, sir, it was.

Chairman PROXMIRE. It was after?

Mr. HARTMAN. My letter to the Program Management Office was dated 26th of August, 1968.

Chairman PROXMIRE. Did the FBI discuss this with you at all?

Mr. HARTMAN. No, sir; they did not.

Chairman PROXMIRE. They did not pass on their information that they had received from two previous witnesses.

Mr. HARTMAN. The FBI did not discuss this with me at all.

Chairman PROXMIRE. I did not say with you. Did they discuss it with anyone in the Air Force so far as you know?

Mr. HARTMAN. I learned at a later date that they had discussed this with Captain Gallagher of the Navy.

Chairman PROXMIRE. You learned at a later date they had discussed it with somebody in the Air Force but not with you or with the Navy?

Mr. HARTMAN. With the Navy, who have program management responsibility. This is a joint Air Force-Navy program.

Chairman PROXMIRE. What was the name of the man with whom it was discussed?

Mr. TREMBLAY. If I may correct you, I believe the story was Captain Gallagher was interviewed by the FBI, but I do not believe that he received a copy of the report.

Mr. HARTMAN. That is correct.

Chairman PROXMIRE. A copy of what report?

Mr. TREMBLAY. Of an FBI report.

Chairman PROXMIRE. FBI report?

Mr. TREMBLAY. Yes, sir.

Chairman PROXMIRE. My time is up. I will be back with a couple of more questions.

Congressman Conable?

Mr. CONABLE. Mr. Hartman, was this plane, was the testing of this plane completed on schedule? And did it meet the qualifications ultimately that the Government had set down?

Mr. HARTMAN. Your question was was the testing of this aircraft?

Mr. CONABLE. Yes.

Mr. HARTMAN. Completed on schedule?

Mr. CONABLE. Yes.

Mr. HARTMAN. I would like to submit that to the record at a later time.

Mr. CONABLE. Was it delayed in any respect because of the controversy attending this particular brake?

Mr. HARTMAN. There were no delays in the program because of the brake.

Mr. CONABLE. Was there any additional cost to the Government because of the controversy attending this particular brake?

Mr. HARTMAN. To my knowledge there was no additional cost to the Government.

Mr. CONABLE. Mr. Tremblay?

Mr. TREMBLAY. Yes, sir.

Mr. CONABLE. Did you have any evidence of problems with the report prior to your having rejected the qualification report?

Mr. TREMBLAY. The only evidence that I had was a flight test report indicating that they had had some difficulty at Edwards Air Force Base, and the discrepancies of the report were in comparison to the requirements that were established by the approved specification document.

Mr. CONABLE. The flight test report was before the qualifications report had been reviewed then?

Mr. TREMBLAY. There was a report of an incident of the brake seizing; yes, sir.

Mr. CONABLE. Is that usual? Do you usually have a flight test before completion of the qualification report?

Mr. TREMBLAY. I believe the qualification report was completed in May.

Mr. HARTMAN. If I may, I would like to answer that.

Mr. CONABLE. Yes.

Mr. HARTMAN. It is normal practice that you do not wait until the components are completely qualified before you put it into flight testing. You do sufficient testing, laboratory testing, to determine that it is safe for flight, and this was done. The brake was in the flight test program simultaneously with the completion.

Mr. CONABLE. In other words, reliance is placed on laboratory tests before the report is approved. This is quite a normal procedure?

Mr. HARTMAN. That is correct, sir.

Mr. CONABLE. Did the original specification for this brake set out that it should be a 4-rotor brake or were they performance specifications?

Mr. HARTMAN. The original specification was performance specification.

Mr. CONABLE. Do you know if the decision to go to a 4-rotor brake instead of a 5-rotor brake was LTV's or Goodrich's?

Mr. HARTMAN. Mr. Tremblay, can you answer that? I do not know.

Mr. TREMBLAY. I believe it was a joint agreement.

Mr. CONABLE. A joint agreement; in other words, worked out by the general contractor?

Mr. TREMBLAY. Yes, sir.

Mr. CONABLE. Mr. Tremblay, have you reviewed the GAO report on this brake?

Mr. TREMBLAY. Yes, sir, I have.

Mr. CONABLE. In your opinion do the data discrepancies noted constitute significant deviation from what the report should have shown?

Mr. TREMBLAY. The deviations that I observed were of a general nature and I could not tell specifically what the variations were.

Mr. CONABLE. But they were sufficiently significant so that these deviations were a part of your decision to reject the qualification report; is that right?

Mr. TREMBLAY. The qualification report was rejected at least 6 months ahead of the GAO report.

Mr. CONABLE. And that was based on the sort of discrepancies the GAO report——

Mr. TREMBLAY. No, sir.

Mr. CONABLE. It was not?

Mr. TREMBLAY. No, sir. Our disapproval of this report was based exclusively upon the inability of the brake to meet the specification performance requirements.

Representative CONABLE. Did you carry on an independent investigation of the data then?

Mr. TREMBLAY. I do not believe I understand your question, sir.

Representative CONABLE. Did you yourself carry on independent investigation of the data outside the report and certainly outside the GAO report?

Mr. HARTMAN. Sir, the only review that was made by us was of the submitted qualification test report and based upon the data presented in that report, that report was not accepted.

Representative CONABLE. Is this the usual procedure that is followed?

Mr. HARTMAN. Yes, sir.

Representative CONABLE. It is. Now the qualification test report has the Government inspector's signature on it.

Mr. TREMBLAY. Yes, Sir.

Representative CONABLE. Does that operate to relieve LTV or Goodrich of any responsibility for the accuracy of the figures reported?

Mr. TREMBLAY. It is my interpretation that it does not.

Representative CONABLE. Why is that required?

Mr. HARTMAN. I am not sure that it is really required, but I do not know that we are the right people to respond to that question.

Representative CONABLE. Certainly it means something for the Government inspector to sign the report.

Mr. TREMBLAY. Technically to me, sir, it has no real significance except that for the fact that——

Representative CONABLE. He does not certify to anything, does he?

Mr. TREMBLAY. No, sir.

Representative CONABLE. I do not understand that. Would it be your opinion that the safety of test pilots was endangered by a defective 4-rotor brake, defective in the manner in which this was?

Mr. HARTMAN. No, sir.

Representative CONABLE. Why do you say that? Because of the circumstances under which the plane is tested?

Mr. HARTMAN. That is right. This is fairly normal practice that one does test new equipment such as this, and it is in a category I flight test program, which is conducted by the prime contractor, in this case LTV. We have qualified, or they have qualified—highly qualified—test pilots who are conducting these tests, in this case upon the brake for the sole purpose of determining its adequacy for later use in aircraft that will be flown by the Air Force.

Representative CONABLE. In other words, the procedures used were normal procedures, and they did turn up the defect as they are designed to do, and no serious risk was involved as long as the test pilot knew his business, is that correct?

Mr. HARTMAN. That is my opinion, sir.

Representative CONABLE. I think that is all.

Senator PROXMIRE. Along that last line, in responding to Mr. Conable, you indicated that you did not think there was a danger to the pilot or the aircraft in this case, is that correct?

Mr. HARTMAN. I did not believe there was an unusual danger, because this kind of a test program does exhibit danger and risk to the test personnel.

Chairman PROXMIRE. The FAA seems to disagree with that. I just read into the record before and I want to read again in your presence and ask you to comment on this observation:

GAO said in response to our question regarding pilot safety and structural damage Federal Aviation Administration officials state "that warping or welding" and it was testified by Mr. Lawson who was present at the time of the Edwards Air Force brake tests that the brakes welded—warping or welding of the brakes would blow out the tire which in turn might cause collapsing of the landing gear.

Might cause breaking of the hydraulic lines and/or puncturing of the gas tanks located in the wing.

They further stated the most likely danger was a fire due to the combination of the heat in the brakes and the leaking hydraulic fluid and/or jet fuel.

Do you feel the FAA was being too alarmist in this case, that this is not a danger?

Mr. HARTMAN. I believe they are being a little severe or extreme.

Chairman PROXMIRE. Why wouldn't this be a possibility?

Mr. HARTMAN. I cannot say that it is not a possibility.

Chairman PROXMIRE. Why is it so remote?

Mr. HARTMAN. Because usually the brake seizure is at relatively low speeds. The pilot does have the capability to steer the airplane down the runway. The testing is done at a place such as Edwards where you have extremely long runways, where you have fire protection, ambulance, and what not standing by.

Third, the brake itself, the wheel itself—even if you blow a tire, which is usually the first thing that happens, the wheel itself will not disintegrate. It is designed so that it will not disintegrate, and I would like Mr. Tremblay to amplify on this if he feels that he should.

Mr. TREMBLAY. That is the case.

Chairman PROXMIRE. Mr. Tremblay?

Mr. TREMBLAY. We do encounter tire failures, tire blowouts. The frequency of occurrence of fires as a result of the tires blowing out are very minor. They are not minor in nature, but they are very infrequent.

Chairman PROXMIRE. I just have a few more questions I would like to ask.

In the GAO reports on the A7D 4-rotor brakes it is stated:

Brake pressure was released at 10 miles per hour and the wheel permitted to coast or taxi for ten or fifteen seconds.

The report further states that military specifications require the brake to bring the wheel to rest. An Air Force engineer told GAO that:

He considered the failure to come to a complete stop was unacceptable because torque stresses reach their peak during the ten to zero miles per hour velocity.

Gentlemen, in your professional opinion when conducting qualification tests on a brake, is it permissible or is it not permissible for the manufacturer to release brake pressure near the end of the simulated stops in order to eliminate any intense vibrations and thereby prolong the life of the brake?

Mr. TREMBLAY. It is not.

Chairman PROXMIRE. Supposing that during a qualification test there were instrumentation failures and critical temperature or other information was not reported as was the case in the 47D qualification as documented numerous times by the GAO. Would it be acceptable practice for the manufacturer to report the figures he felt might have been reported had instrumentation not failed?

Mr. TREMBLAY. No, sir; that would not be acceptable.

Chairman PROXMIRE. If during qualification tests recorded temperatures were consistently higher than the manufacturer had anticipated, as reported by the GAO on the A7D brake tests would it be acceptable for him to include in the qualification report the temperatures that he felt should have been developed in the brake rather than those temperatures which were actually recorded?

Mr. TREMBLAY. No, sir; it would not.

Chairman PROXMIRE. It would not. All right, now let me ask finally, I want to ask you this. I would like to ask you if the real facts of the test had been known, would you, Mr. Tremblay have advised that the flight test proceed?

Mr. TREMBLAY. I am not really sure what the real facts are.

Chairman PROXMIRE. All right, if the facts had been known as have been testified this morning by Mr. Vandivier.

Mr. TREMBLAY. I would have requested that they stop the flight test, yes.

Chairman PROXMIRE. That the flights not go ahead?

Mr. TREMBLAY. Yes, sir.

Mr. HARTMAN. Mr. Chairman, if I may, I think that at a minimum we would have had a more detailed review. We would have had to insist upon that before we made the decision with respect to whether the flight tests would continue.

Chairman PROXMIRE. At any rate you went ahead on the basis of this report?

Mr. TREMBLAY. No, sir.

Chairman PROXMIRE. To fly the plane which indicated that the brakes were safe enough and they were not safe enough, at a minimum as you say, Mr. Hartman, you would have asked for more information, and Mr. Tremblay, you testified that you would not have advised that the plane fly?

Mr. TREMBLAY. Mr. Chairman, the report was not reviewed until August 1968, and these tests were conducted in June.

Chairman PROXMIRE. Why didn't the Air Force find out what was in the FBI report?

Mr. TREMBLAY. As an engineer, sir, I do not know.

Mr. HARTMAN. As engineers that is not in our——

Chairman PROXMIRE. What is that, sir?

Mr. HARTMAN. As engineers that is not in our scope of responsibility.

Chairman PROXMIRE. When you heard that the FBI was involved why didn't you inquire about it?

Mr. HARTMAN. This is a management task as far as I am concerned. The management, we knew, were aware of it.

Chairman PROXMIRE. Did you advise management under these circumstances that the FBI was involved, that you ought to be informed?

Mr. HARTMAN. We advised management of the knowledge that we had that there was an FBI investigation.

Chairman PROXMIRE. Mr. Conable?

Representative CONABLE. One last question. I am referring now to a statement which was made by Mr. R. G. Jeter, vice president and general counsel of the B. F. Goodrich Co. I would like to ask you if this is a correct statement:

> It is most significant that 4-rotor brake knitting problem referred to above could not have been predicted from the indoor laboratory tests which the contract required regardless of how precisely these tests may have been performed. And the knitting problem was the only significant field problem with the 4-rotor brake.

It that correct, or would you challenge that statement?

Mr. TREMBLAY. I believe I would challenge that statement, sir, because——

Representative CONABLE. You disagree with that statement, Mr. Tremblay?

Mr. TREMBLAY. Yes, sir; I do.

Representative CONABLE. In other words, it could have been predicted that there would be a knitting problem from the indoor laboratory tests if the tests were conducted correctly?

Mr. TREMBLAY. That is my opinion; yes.

Chairman PROXMIRE. So we have the testimony of Mr. Lawson to that effect, and we have your testimony to that effect.

Gentlemen, thank you very much for your very helpful testimony.

Mr. Hartman, would you return just for a minute. We want to find out from you, and I will ask you as you come up, to whom the FBI talked. You said as I understand it it was somebody from the Navy, a captain in the Navy. We did not get his name. If you know that, we would appreciate knowing who it was.

Mr. HARTMAN. It was Captain Gallagher.

Chairman PROXMIRE. Captain Gallagher?

Mr. HARTMAN. Yes, sir.

Chairman PROXMIRE. Can you identify him further, his first name and his position?

Mr. HARTMAN. Thomas is his first name.

Chairman PROXMIRE. Thomas?

Mr. HARTMAN. Captain Thomas Gallagher. He is head of the Joint Air Force-Navy Program Management Office, and has management responsibility for all A7 airplane procurement.

Chairman PROXMIRE. Program manager, fine. Thank you very much.

Our next witnesses are from the General Accounting Office. We have here Richard W. Gutmann, Guy A. Best, Stanley R. Eibetz, and Jerome P. Pederson.

Mr. Gutmann, you have the honor of leading this delegation.

STATEMENTS OF RICHARD W. GUTMANN, DEPUTY DIRECTOR, DEFENSE DIVISION; GUY A. BEST, ASSISTANT DIRECTOR, DEFENSE DIVISION; STANLEY R. EIBETZ, ACTING ASSISTANT DIRECTOR, DEFENSE DIVISION; JEROME P. PEDERSON, SUPERVISORY AUDITOR ACCOUNTANT, DEFENSE DIVISION; AND STEVEN HAYCOCK, ASSISTANT GENERAL COUNSEL, GENERAL ACCOUNTING OFFICE

Mr. GUTMANN. Yes, I do.

Chairman PROXMIRE. You have a concise statement. It will only take 3 or 4 minutes to read it. Let me say, before you begin, that the GAO report, "Review of the Qualification Testing of Brakes for the A-7D Aircraft," will be included in the record at the conclusion of today's proceedings. (See Appendix.)

Go right ahead, Mr. Gutmann.

Mr. GUTMANN. Mr. Chairman and members of the subcommittee, we are pleased to appear before the subcommittee today in response to your invitation of August 7, 1969.

The review of the brake qualification testing performed by the B.F. Goodrich Co. was performed in response to your request of May 13, 1969, for an inquiry into (1) the accuracy of the reported qualification test results; (2) the effect of defective brakes on the test pilot's safety; (3) the identification of additional costs, if any, incurred by the Government to obtain an acceptable brake; and (4) the responsibilities of the Government, including Air Force actions, in the qualification testing.

The A-7D aircraft was purchased for the Air Force by the Navy from LTV Aerospace Corp., Vought Aeronautics Division, Dallas, Tex. LTV awarded a subcontract to the B.F. Goodrich Co., Aerospace and Defense Products Division, Dallas, Tex., for the development and production of brakes for the A-7D aircraft. The subcontract was performed at Goodrich's plant in Troy, Ohio.

In performing this assignment we took the following steps: (1) we reviewed the qualification test procedures and compared the actual and reported qualification test results at Goodrich; (2) we discussed qualification test procedures with LTV officials and Air Force engineers; (3) we reviewed the applicable specifications for qualification testing; (4) we discussed potential harm to pilot and aircraft resulting from defective brakes with the Federal Aviation Administration, Air Force, Navy, and LTV officials, and LTV, Navy, and Air Force test pilots who had flown the A-7D aircraft, (5) we reviewed prime contractor and military flight reports and flight discrepancy sheets; (6) we reviewed the prime contract, the subcontract, and other documents and correspondence relating to the pricing and/or configuration of the brakes; (7) we discussed the effect of brake problems on aircraft testing and delivery with an Air Force engineer and LTV officials; and (8) we reviewed documents regarding the prime contractor and Government responsibilities with personnel of LTV, the Air Force, and the Defense Contract Administration Services District Dayton, personnel.

The results of the review have been summarized in the digest of our report to you, Mr. Chairman, dated July 3, 1969, and in a subsequent letter dated July 11, 1969.

In summary our work shows that:

In some instances Goodrich's test procedures for the four-rotor brake did not appear to comply with specification requirements or normal industry practice.

Goodrich's qualification report on the results of testing the four-rotor brake contained some discrepancies that may be considered significant.

Chairman PROXMIRE. Would you repeat that statement again?

Mr. GUTMANN. Goodrich's qualification report on the results of testing the four-rotor brake contained some discrepancies that may be considered significant.

In our opinion Goodrich should have accurately reported the test results, since in the absence of accurately reported test results it is difficult, if not impossible, to properly evaluate product performance.

Opinions differed as to the potential danger to the pilot and damage to an aircraft due to brake failure. However, no significant aircraft damage due to the use of the four-rotor brake had been reported.

Goodrich offered to, and did, replace the four-rotor brake with a new five-rotor brake without any apparent increase in cost to the prime contractor or the Government. We were advised that the change did not cause any delays in the delivery or testing of the aircraft.

The prime contractor's procedures and those of the Defense Contract Administration Service District were inadequate to protect the Government's interests in the qualification tests of the four-rotor brake.

The Department of the Air Force protected the Government's interest by withholding approval of the qualification report.

As you know, Mr. Chairman, in this case we did not follow our usual practice of obtaining written comments on the matters discussed in the report from the parties involved; that is, Goodrich, LTV, and the Department of Defense.

This concludes my statement Mr. Chairman. My colleagues and I would be pleased to try to answer any questions that the subcommittee may have.

Now if I could introduce my colleagues; to my immediate right is Mr. Guy Best, Assistant Director.

Mr. Best is now assigned to our new major weapons systems acquisition group in the defense division, and he is an industrial engineer who handled the technical aspects of this review.

To his right is Mr. Steven Haycock, representing our general counsel's office.

To my left is Mr. Stan Eibetz, acting assistant director of our procurement group, who handled the audit management of this job, and to his left is Mr. Jerome Pederson, who is the audit manager under Mr. Eibetz.

We would be pleased to answer any questions you might have.

Chairman PROXMIRE. Thank you very much, Mr. Gutmann.

I am glad again to stipulate that there is not any question that there was no additional cost to the Government as a result of this situation which you found, and I think that is correct, that issue was never raised by me. I do not know if anyone else raised it. It has not caused any delays in delivering or testing the aircraft. I think it is good to state this even though it has not been raised because I think that this kind of suspicion or charge might develop and you emphasized it and I want to emphasize it again, that Goodrich did not, nor indeed did the four-rotor brake at any time cause a loss of life or damage to property.

Mr. GUTMANN. That is correct.

Chairman PROXMIRE. On the other hand, there is some difference of opinion, as you put it, as to the potential danger to the pilot and damage to the aircraft, and there is not any question that there were discrepancies involved here, and as you put it:

In our opinion Goodrich should have accurately reported the test results since in the inaccurate reporting of test results it is difficult if not impossible to evaluate product performance.

You say:

The prime contractor's procedures and those of the Defense Contract Administration Services District were inadequate to protect the Government's interests in the qualification tests of the four-rotor brake.

How were these procedures inadequate?

Mr. GUTMANN. Well, sir we feel that the prime contractor as well as the Defense Contract Administration Services District should have looked into the basic raw data in support of the test, at least to an extent, perhaps not 100 percent, but at least to an extent that would satisfy themselves that they had an accurate report.

Chairman PROXMIRE. Mr. Tremblay testified to us that he tried and was unable to get this raw data.

Mr. GUTMANN. That is correct; yes, sir.

Chairman PROXMIRE. It was just denied him, so he recommended that the brakes not be approved.

Mr. GUTMANN. That is correct.

Chairman PROXMIRE. After your investigation into A-7D qualification procedure why did GAO recommend changes in the Government's responsibility for brake testing procedures?

Mr. GUTMANN. This goes to the question of the meaning of the DCAS signature on that qualification test report. We feel that their procedures did not give real substance to the signature. They should have looked behind the report more than the procedures called for, and subsequently the DCAS did modify their procedures to provide a little more substance and meaning to that signature.

Chairman PROXMIRE. One of the things they did as I understand it is to provide for the presence of the Air Force, LTV and Goodrich, the subcontractor, all of them when these brakes were finally tested. We have been told that the 4-rotor brake, in some of the preliminary testing, LTV was present. The Air Force was never present at any time, and the final testing apparently was conducted entirely by Goodrich, not in the presence of the prime contractor or the Air Force?

Mr. GUTMANN. That is correct.

Chairman PROXMIRE. This is part of your recommendation?

Mr. GUTMANN. Yes.

Chairman PROXMIRE. Very good. And this was a change which resulted. I am corrected. The changes were made by DCA Dayton, not by the Air Force.

Representative CONABLE. It is not an Air Force inspector.

Mr. GUTMANN. That is true, it is DCA's responsibility for the Air Force.

Chairman PROXMIRE. Were there discrepancies between the data shown in the B. F. Goodrich report and the data shown by DCA's?

Mr. GUTMANN. Yes, sir.

Chairman PROXMIRE. Was data reported by Goodrich as to the A-7D brake when in fact test instruments that were supposed to record the data were not working?

Mr. GUTMANN. With your permission, Mr. Chairman, I would refer this question to Mr. Best.

Chairman PROXMIRE. Mr. Best?

Mr. BEST. That is correct.

Chairman PROXMIRE. That is correct. In other words, data was reported by Goodrich in their report when in fact test instruments that were supposed to record the data were not working?

Mr. BEST. That is correct, sir.

Chairman PROXMIRE. What explanation did Goodrich personnel have to offer for the discrepancies and for the instances where data was reported when in fact none was recorded?

Mr. BEST. There were different explanations in different circumstances; sometimes no explanation given.

Chairman PROXMIRE. In some instances did they say they rationalized the data?

Mr. BEST. That is correct, sir.

Chairman PROXMIRE. What does that mean to you?

Mr. BEST. I do not have an interpretation of it, Mr. Chairman.

Chairman PROXMIRE. It seems to me that it means that they changed the data, is that right? When they say they rationalized, they changed it?

Mr. BEST. What was evident to me was that the raw data, as best we could read it and identify it to the item in the test report, was not the same as had been recorded.

Chairman PROXMIRE. So it had been changed. You cannot really rationalize engineering data very well, can you? It is not likely?

Mr. BEST. Yes, there are reasonable adjustments to be made in instrumented information. For example, to delete information because it is erroneous, because you know from experience that you should not use it.

Chairman PROXMIRE. Very good. Were these reasonable adjustments that were made in your view or were they changes that were made to make the brake appear qualified when it was not?

Mr. BEST. I would like to answer the first part of the question first, Mr. Chairman.

Chairman PROXMIRE. All right.

Mr. BEST. I could find no consistent reason in the adjustments that I identified. In other words, they seemed to be individual adjustments rather than the kind that you would apply because you know that an instrument records so much off, either in a proportional or in a constant error manner.

Chairman PROXMIRE. To help us come to a conclusion on this, were they changes in your view, did they give an honest picture of the brake performance?

Mr. BEST. Taken as a total, no, sir.

Chairman PROXMIRE. They did not give an honest picture taken as a total?

Mr. BEST. No, sir.

Chairman PROXMIRE. Let me ask you gentlemen this, because I think this whole thing goes to a far broader spectrum than Goodrich. What are the Defense Department's responsibilities to administer subcontracts awarded by a prime contractor?

First tell us what the law and the Defense Department regulations require of the Defense Department?

Mr. GUTMANN. Mr. Chairman, I would ask Mr. Haycock to address himself to the question of law here.

Chairman PROXMIRE. Mr. Haycock?

Mr. HAYCOCK. Mr. Chairman, I know of no law which requires the Government or the prime contractor to supervise subcontracts and quality assurance procedures as were here involved. The armed services procurement regulations, however, do impose responsibility on a prime contractor for his subcontractors on the quality of their products.

Government inspection is provided for by the regulations when it is deemed necessary by the agency involved.

Chairman PROXMIRE. I think it can be most useful if I ask this in this specific instance with regard to Goodrich then. Tell us how it carries out its responsibilities in the B. F. Goodrich case, the responsibilities for the subcontractor's performance, the Government's responsibility, for the subcontractor's performance. What did the Defense Department do to protect the interests of the Government in this case?

Mr. HAYCOCK. What did they do?

Chairman PROXMIRE. What should they do and what they did.

Mr. HAYCOCK. Well, that is a little difficult to answer. It would depend on——

Chairman PROXMIRE. Let me ask it this way. Did the Government exercise proper diligence with regard to the testing of the brake in question?

Mr. GUTMANN. Mr. Chairman——

Chairman PROXMIRE. As I understand it, the report said it did not.

Mr. GUTMANN. That is right, sir. We do not feel that it did. As Mr. Haycock stated the basic responsibility is vested in the prime contractors in accordance with the armed services procurement regulations, and implementing instructions. The agency is, however, and did in this case, have a representative at the contractor's plant, a DCAS man. They exercised some degree of quality assurance surveillance over subcontractor's products.

In this particular instance, we feel that quality assurance was lacking, in that the DCAS representative did not observe any of the tests, and did not really assure himself as to the quality of the product.

Chairman PROXMIRE. Then let me ask you this. In your report GAO concludes that no additional costs were charged the Government as a result of changes to the brakes, something that I said we should know. Yet it does seem obvious that completely changing over from a 4-rotor to a 5-rotor brake would have cost something to Goodrich. Is this correct and if so what additional cost did Goodrich incur?

Mr. GUTMANN. We are unable to determine what the additional cost was to Goodrich, Mr. Chairman, and I would like to qualify just a little bit our statement that no additional cost was borne by the Government, for this reason. It is possible that some of those costs found their way into Goodrich's overhead accounts and subsequently distributed to other Government contracts.

During the period of time that we had for this review, we could not get deeply into Goodrich's accounting system and determine if that happened.

Chairman PROXMIRE. That is exactly what I am getting to because I wanted to ask you this in connection with it. In determining whether any increased costs were passed down to LTV or to the Government did you have access to the books and records of Goodrich and LTV and were books and records examined or audited to make this determination?

Mr. GUTMANN. Yes, sir, I know of no instance where we had difficulty obtaining books and records.

Chairman PROXMIRE. You checked this fact against their records to determine whether there was any additional cost?

Mr. GUTMANN. What we did was simply check the engineering change orders to prime contracts and subcontracts. We did not find any increase in price, so we know that there were no direct charges under this prime contract.

Chairman PROXMIRE. How about the cost records?

Mr. GUTMANN. We did not get into the cost records to make a determination as to whether or not any of these costs became an overhead item.

Chairman PROXMIRE. Let me ask did GAO ever examine or audit the books, does GAO examine or audit the books and records of subcontractors?

Mr. GUTMANN. Yes, sir.

Chairman PROXMIRE. You do. The other question I have relates to one that has been asked of the other engineers and I would like to ask Mr. Best if it is your opinion that the statement made—that will be made—by Mr. Jeter, Congressman Conable and I referred to it:

> It has never been determined whether the knitting problem resulted from the brake design or was because of an incompatibility between the brake and its associated parts of the braking system.

I would like to ask you, Mr. Best, if it is your opinion, based on Mr. Lawson's testimony, that knitting problem was a result of design?

Mr. BEST. Mr. Chairman, I would like to beg off on this question on the basis that the work that I did was fairly narrowly circumscribed, and while I am an engineer, I am not a specific brake specialist.

Chairman PROXMIRE. You would not contradict the testimony by the previous engineer, Mr. Lawson?

Mr. BEST. I would not contradict it; no, sir.

Chairman PROXMIRE. I would like to ask you the truth about this statement that will be subsequently made.

> It is most significant that the 4-rotor brake knitting problems referred to above could not have been predicted from the indoor laboratory tests which the contract required regardless of how precisely these tests may have been performed, and the knitting problem was the only significant problem with the 4-rotor brake.

Do you think that could have been predicted on the basis of the laboratory tests or not?

Mr. BEST. I am certain that the tests are designed for the purpose of finding just such problems as the knitting problem, and this is why we test components before we test larger assemblies.

Chairman PROXMIRE. So you feel the whole purpose of the test would be to predict whether or not the knitting problem among others could have been developed, were developed?

Mr. BEST. Yes. And I would hope that this test were a part of their continuing design procedures, to conduct tests on their own as well as for the customer.

Chairman PROXMIRE. Then you would not agree with the statement that the 4-rotor brake knitting problem "could not have been predicted from the indoor laboratories."?

Mr. BEST. I generally disagree with that statement.

Chairman PROXMIRE. Mr. Conable?

Representative CONABLE. You would agree I am sure that you might have a knitting problem even though the tests showed that it was not likely?

Mr. BEST. Yes, sir, I agree to that, too, because more strenuous circumstances might arise in the field, a completely different environment.

Representative CONABLE. I am interested, Mr. Gutmann, in the wording you have used here in your summary. You say:

> Goodrich's qualification reports and the results of testing the 4-rotor brake contain some discrepancies that may be considered significant.

You did not really come right out and say it was significant. Why did you use that wording? Simply because of the limitations in your investigation? They might be significant and then again they might not. Why did you say it that way?

Mr. GUTMANN. Well, sir, we did not intend to use that word "may" in the sense of "might." It is not the conditional "may."

Representative CONABLE. I see. In other words, you considered that they were significant?

Mr. GUTMANN. Yes, sir.

Representative CONABLE. Fine, I am glad to have that cleared up. Now the qualification report was one check in the production process and not the only one, and I am interested in your statement here that the procedures were inadequate to protect the Government's interest. The fact is this difficulty was discovered by other check down the line; namely, the flight test.

Is it your feeling that this was inadequate limited to the lack of Government participation in the inspection process at the time of the laboratory tests, or what is your feeling?

Mr. GUTMANN. Yes, sir. Although the flight tests subsequently revealed some problems with the brakes, it appeared to us that for the qualification testing to have real meaning and value, it should be performed before the flight test which is not necessarily the case.

Representative CONABLE. Yes.

Mr. GUTMANN. And it is basically the lack of participation in the qualification testing where we consider the procedures inadequate.

Representative CONABLE. You do not feel that we have anything but a quality product in the plane that has finally been evolved here, do you?

Mr. GUTMANN. We know of nothing adverse in this regard.

Representative CONABLE. I quite agree that it is ridiculous to have a Government inspector sign the report unless it is going to mean something, and I am confused about why he did sign the report. There may be very good reasons for not involving him too directly in the process, which is essentially, at this stage anway, a responsibility between subcontractor and contractor, but it certainly is confusing to have him apparently attesting to something although the statement he makes does not appear to guarantee a darn thing. I quite agree with you that that is a confusing aspect of this, why he should have signed the report at all is shrouded in mystery.

Mr. GUTMANN. Yes.

Representative CONABLE. Is that usual at this stage? Do they require a Government signature on the report?

Mr. GUTMANN. Yes, they do, and in many instances I am afraid it simply means that the man has seen it.

Representative CONABLE. That is all I have, Mr. Chairman.

Chairman PROXMIRE. Thank you very much, gentlemen. We appreciate your appearance.

Mr. GUTMANN. Thank you, sir.

Chairman PROXMIRE. Our final witnesses this morning are from the Goodrich Co.: Mr. R. G. Jeter, vice president and general counsel, and Mr. Robert L. Sink, the projects manager, aircraft wheel and brake design.

Mr. Jeter, you go right ahead, sir.

STATEMENT OF R. G. JETER, VICE PRESIDENT AND GENERAL COUNSEL AND SECRETARY OF THE B. F. GOODRICH CO., AKRON, OHIO, AND ROBERT L. SINK, PROJECTS MANAGER, AIRCRAFT WHEEL AND BRAKE DESIGN SECTION, B. F. GOODRICH WHEEL AND BRAKE PLANT

Mr. JETER. Mr. Chairman, members of the committee, my name is R. G. Jeter and I am vice president, general counsel and secretary of the B. F. Goodrich Co.

I have with me on my left Mr. Robert Sink, who is a senior wheel and brake design engineer and projects manager.

I would like if I may to read my statement and interject a few remarks in response to statements which have been made here this morning.

The B. F. Goodrich Co., now in its 99th year, for many years has been a leading manufacturer of airplane wheels, brakes, tires, and other equipment. Many thousands of our airplane brakes are now in service on commercial airlines and military planes, both in this country and throughout the world.

I am sure that some people who have listened to this testimony this morning might wonder whether our company is capable of making a satisfactory airplane brake, and let me assure them that we are. We are, in fact, one of the very leading manufacturers in the world.

We manufacture the brakes for the Boeing 707, 720, 727, and the new, very large Lockheed L–1011. The Lockheed Jetstar, the Beech Kingair, and other commercial and private planes also use B. F. Goodrich brakes.

In the military field we have supplied the wheels, brakes, and tires for the giant Lockheed C–5A transport, the General Dynamics F–111 fighter interceptor, the Lockheed SR–71, the North American XB–70 supersonic bomber, the LTV A–7D under discussion here, as well as a variety of other fixed wing and helicopter type military aircraft now in service, and we expect to manufacture a great many hundreds more before we are finished.

In listening to the testimony of the two first witnesses, I just wanted to suggest that to me it seemed incredible that more than 30 engineers, professional men who work at this plant, our Troy plant, would continue to work for a company which would countenance any, any of the conduct described by Mr. Vandivier and Mr. Lawson. It appears that everybody at our Troy plant is out of step, or were out of step, except these two men. That is the substance of their testimony.

Now the Chairman has raised the question, as has Mr. Conable, what did the company stand to gain by this? Why would the company do this? Why would we deliberately falsify records? Why would we produce a defective brake? There is not any reason under God's creation why we would do it. The fact of the matter is we contracted with LTV to manufacture satisfactory, workable, efficient brakes for an aircraft.

This is our obligation under our contract. We contracted to do this for a fixed sum of money—and we are talking about I think $90,000—and this is our obligation.

Now why go and produce a brake and go through all the agony and tests and everything else of producing a defective brake so that we could set about then and manufacture another brake, to design a new brake and manufacture another brake which would work?

What on earth would be the point of this? It escapes my imagination or conception. I do not understand why such a thing could possibly happen.

We engineer and manufacture these airplane brakes and wheels at the plant in Troy, Ohio, which specializes in only these products.

This plant includes laboratory testing facilities for aircraft brakes which are second to none in the industry.

In short, B. F. Goodrich enjoys an excellent reputation within the aircraft industry as a supplier of these products.

This hearing is concerned with airplane brakes supplied by B. F. Goodrich as a subcontractor of Vought Aeronautics Division, of LTV (hereafter referred to as LTV) for the A7D light attack aircraft for the U.S. Air Force, as you gentlemen know.

On June 28, 1967, B. F. Goodrich was awarded a contract by LTV to supply a four-rotor brake for the A7D aircraft.

The four-rotor brake was designed and several were made for the indoor laboratory tests required by LTV in the contract. You understand the tests that were to be performed on this brake were not all of the tests that have ever been conceived by man.

The tests that were to be performed on this brake were the tests specified in the contract, and that is what I shall be talking about. And I say that because at the Chairman's questioning a couple of gentlemen here have disagreed with the statement that the knitting would not have arisen in the laboratory test if they had been most precisely and properly performed, and they have said that that is not so.

Well, the point of the matter is it is so, and I insist upon the statement, if you are taking about laboratory tests prescribed by our contract, so let us just keep that in mind.

Now this brake was designed, several were made, and then upon completion of these indoor tests in May 1968, it was the judgment of the responsible B. F. Goodrich aircraft brake engineers that the four-rotor brake satisfactorily performed the indoor tests and was ready for field testing on the A7D aircraft. Brakes of this design were then installed on a test airplane and given flight tests by LTV pilots at Edwards Air Force Base.

Between May 1968 and January 1969, LTV pilots made, as reported by the General Accounting Office, 229 test flights using the four-rotor brake.

Now let us just keep this in mind also. We are talking about a brake that was on an airplane, or more than one airplane, whichever the case, on which 229 flights were flown by test pilots who, of course, deliberately subjected the equipment, the entire equipment, to the most stringent use.

In all of these 229 test flights the four-rotor brakes performed the braking function. No one has said anything to the contrary here. They brought the plane to a stop, as a matter of fact, in less than the required distance, and these are the records.

There were no brake-related safety incidents involving, and we do not need to use weasel words about this, these are the facts, and the Air Force and LTV's records will substantiate it, there were no safety incidents invoving either the pilots or the planes, a fact confirmed at page 11 of the GAO report.

(See appendix for report.)

However, in these 229 flights, as noted by the GAO report, page 11, the pilot reported 12 flights and I would like to emphasize this now if I may, out of the 229 flights they reported 12 flights during which there were, and I quote "potential" problems with the brake system.

Now that is the heading of the chart in which they record this problem. There were 12 flights out of 229 in which there were "potential" brake problems.

It should be understood at this point—and I am not sure that it is understood—that a brake system on an airplane consists of three principal components, one of which we manufactured, namely the brake, the other an antiskid mechanism, and the third, the brake hydraulic system.

In other words, this is the brake system, and all three of these things are required if you are going to have a brake that functions on an airplane.

Of the three parts, we manufactured the brake. We did not manufacture the other two items. We did not in our laboratory tests of the four-rotor brake prior to flight tests have available to us, we did not test the brake system, the entire brake system, hydraulic and the antiskid mechanism, we did not manufacture.

Pursuing these flight tests of the four-rotor brake—and I say listening to this testimony one might suspect that this brake fell off the airplane and on the first taxi down the runway—LTV flew 229 test flights, and these 12 potential problems which I have mentioned.

Now of the 12 potential problems, only two, in only two of the flights in which the brake system problem was noted was there a problem related to the four-rotor brake—in two flights out of these 229.

This problem was that the brake linings—and our engineers have described this—knitted or fused slightly at low speeds, and this was mentioned a moment ago in connection with safety. This problem occurred at low speeds.

As I say, it has never been determined whether the knitting problem resulted from the brake design, or was because of an incompatibility between the brake and its associated parts of the braking system.

This was not determined because we set upon another course rather than try to blame the problem on some other part.

In the same period—I have mentioned 229 test flights by LTV test pilots—in this same period, military pilots flew 38 test flights with his four-rotor brake. These, of course, were in addition to the 229. The military test pilots reported no brake system problems in the 38 flights which they conducted. Again I say this was not a defective brake that fell off the plane the first time they started down the runway with it. They flew 229 plus 38 flights, test flights, and there were 12 potential problems regarding the brakes in that total number of tests flights, and there were two problems which involved this knitting or sticking together of the parts, whatever they were.

So let us reduce this thing. We can be factual about it I hope, and let us reduce it to its facts. Let us see what the problem is, and this is the problem.

We had a fusing or a knitting in this brake in two flights out of 299 plus 38, a total of 337 flights, and that is the only real brake problem they had on this airplane.

I make the statement—and the chairman has questioned a couple of witnesses about it—and I want to make the statement again, and stand by this statement.

I meant exactly what I said in the statement, notwithstanding what some of the witnesses have said. I say it is most significant that the four-rotor brake knitting problem referred to above could not have been predicted from it, from the indoor laboratory tests which the contract required, regardless of how precisely these tests may have been performed. And the knitting problem was the only significant field problem with the four-rotor brake.

Now I trust I make the point that the statement is based upon testing the brake pursuant to the specifications of our contract, which is what we did.

It was during the period from June 14 to July 5, 1968, in flight testing at Edwards Air Force Base that the knitting problem appeared. The company's engineers immediately initiated a two-phase program to deal with this problem without regard to whether the real cause was the brake itself, or the brake system.

The program was: (1) we set about to study other possible linings for the four-rotor brake which would have a higher fusion level; and (2) we set about to design a five rotor brake in the event the lining development was unsuccessful.

During September 1968, we started testing a new five-rotor brake. This is a month before Mr. Vandivier left our company, but he apparently did not know anything about this.

Concurrently, B. F. Goodrich obtained from LTV an antiskid mechanism and tested it in combination with the the four-rotor brake. These were our first laboratory tests of the entire brake system. The tests of the entire brake system were in no way provided for or involved in our contract, but since we had a problem, we obtained the system, the rest of the system, so that we could make a test with the entire system. And with the entire system our engineers designed a test, and note my words, we designed a test for the purpose of attempting to simulate or duplicate the knitting problem in the laboratory.

We did determine from this test, we concluded at least from this test that a brake lining change would probably not solve the problem, whereas a 5-rotor brake design probably would be satisfactory.

Our engineers reached that conclusion.

Now the chairman has stated that B. F. Goodrich did not "qualify" the five-rotor brake for theA7D until after GAO had made its investigation and recommended improved procedures.

The facts are that B. F. Goodrich satisfactorily completed evaluation tests on the five-rotor brake on October 17, 1968, and the results of these tests were reviewed with LTV on October 21, 1968. The five-rotor brake was formally recommended to LTV on October 29, 1968. The fact of the matter is that the GAO investigation was not begun until many months later, to be precise, on May 28, 1969.

Formal qualification testing of the five-rotor brake was completed in December 1968, and the first shipment of these new five-rotor brakes was delivered to LTV on January 12, 1969.

On February 13, 1969, the formal qualification report for the five-rotor brake was approved by LTV. Beginning January 27, 1969, and continuing to the present time, I am told, the five-rotor brake has been flight tested on an A-7D by both LTV and military test pilots. The test pilots have reported no significant brake problem, and I guess that has been agreed to by everyone here.

The essential facts of this matter I summarize as follows:

1. There have been no safety incidents—personal injury or property damage—resulting from the flight testing of either the four-rotor or the five-rotor brake, the GAO report on pages 10 and 11 are my authority for this statement.

"Air Force, Navy, and LTV/VAD officials generally agreed that the brakes did not endanger the life or safety of the test pilots."

2. The total experience with both brakes was a typical one. And I understand the chairman is talking about the four-rotor brake, but I am talking about both brakes, because we had a contract to perform for the Government, well, for LTV and the Government, and I am telling the story of what happened in the performance of this contract including the four-rotor brake total experience with both brakes on the A-7D, a new airplane, was a typical one. And I am telling you we have thousands of brakes on airplanes flying in this country.

Obviously, the reason a new airplane brake must be subjected to rigid flight testing is because indoor laboratory tests alone do not always provide a reliable guide to the performance of the brake on the aircraft, and I daresay that the Air Force will not disagree with that statement.

3. Now further, B. F. Goodrich engineers moved quickly, and I think my listing of dates substantiates that certainly, to provide a

solution to the knitting problem with no delay in the aircraft program, and the GAO report supports this.

4. The substitution of the 5 rotor-brake, and Mr. Chairman, I trust that you will not further question the conclusion of the General Accounting Office, which was that the 5-rotor brake was in fact provided under the contract with no additional cost to anybody except B. F. Goodrich, and this is the fact of it; and 5, both the LTV and the Air Force have expressed their satisfaction with our 5-rotor brake.

GAO Report of Its Investigation

Now I want to refer to the General Accounting Office Report of its investigation of it and I would like to point out at this time that Mr. Vandivier has testified here that he has told his tale to the General Accouning Office. It had the benefit of this story of his for whatever it was worth in the course of their investigation.

On May 28, 1969, the GAO began its investigation of the B. F. Goodrich A7D aircraft brake program.

I might interject at this point to say it was a rather thorough investigation. They were at our plant 8 or 10 days, I am not sure of the exact count, but quite a few days. They were provided access to all test data which had been compiled in the indoor testing of the 4-rotor brake.

Engineers of B. F. Goodrich who were directly associated with this project and who had worked in the program cooperated fully in answering questions and explaining the test data.

We now know that early in July 1969 the GAO delivered its report to Senator William Proxmire. The GAO did not submit copies of the report to the Defense Department, LTV, or B. F. Goodrich for either review or comment. In fact, B. F. Goodrich first received the GAO Report on August 4, 1969, one day after Senator Proxmire had delivered his statement to the news media.

Further, the Senator did not contact B. F. Goodrich until after his public accusations.

There are only two "Findings and Conclusions" in the GAO Report which are in the least critical of B. F. Goodrich. It is significant that the news statement B. F. Goodrich issued on August 4, 1969, in response to Senator Proxmire's press release, incorporated all the "Findings and Conclusions" of the GAO Report.

First—B. F. Goodrich's Test Procedures

Now as to the critical findings, the first regarded our test procedures. GAO stated that in some instances our laboratory test procedures for the 4-rotor brake "did not appear to comply with specification requirements or normal industry practice." Our answer:

(*a*) LTV approved our interpretation of the contract specifications to end the test runs in a rolling stop. The energy level over each test run was maintained as required, which is the principal purpose of the test runs. The precedent for the rolling stop used in this test was established at the Wright-Patterson Air Force Base testing laboratory a number of years ago when the Air Force was qualifying military aircraft brakes, and this technique is often used in testing other aircraft brakes.

You may be interested to know that the brakes of the XB70 supersonic bomber were qualified in test runs with a rolling stop.

(*b*) GAO questioned the sequence in which the normal energy stops and the overload energy stops were run in this test, but GAO admits (GAO Report, page 7) that test sequence requirements were not specified in the contract. The sequence of the normal and overload energy stops B. F. Goodrich used was discussed with and approved by LTV.

(*c*) Finally, GAO states (report, page 7) that, for some runs of the test, stators were interchanged between the No. 1 and No. 3 positions within the brake. The report acknowledges B. F. Goodrich's explanation that this was a laboratory technique for studying special wear effects. All components were subjected to the full qualification test, however.

Second—The Alleged Discrepancies

Now the second finding that I refer to as criticism perhaps in the GAO Report relates to alleged discrepancies. The second and only other respect in which the GAO Report is critical is that it states that "Goodrich's qualification report on the results of testing the four-rotor brake contanied some discrepancies that might be considered significant."

I want to say in this connection, Mr. Tremblay has testified here from the Air Force that Goodrich refused to furnish data to the Air Force. This is not a fact. We refused to transport this data to Wright Patterson field, and we offered to submit the date for review at our Troy plant.

Now those are all the facts on the submission of data to the Air force. We do not take the data out of our plant, and this is our practice I am told for many years. But the offer was made for the Air Force to review this data at the Troy plant.

Chairman Proxmire. Let me just interrupt on this point, please.

Mr. Jeter. Yes, sir.

Chairman Proxmire. Did you at any time say that this data was proprietary?

Mr. Jeter. We did say it was proprietary.

Chairman Proxmire. You said it was proprietary.

Mr. Jeter. And we kept it in our plant.

Chairman Proxmire. But you did say it would be available if the Air Force would come to the plant?

Mr. Jeter. At our plant, yes, sir. We did say, sir, it was proprietary. We did say that.

Now responding to this claim by GAO:

Our answer: Appendix A of the report identifies 16 data items characterized as "discrepancies that may be considered significant." That is to say, there are 16 data items criticized out of more than 250 items the GAO examined. Therefore, we must conclude that 94 percent of the items were not questioned.

Of the 16 so-called "discrepancies," three of them are against our interests for the purpose of the test report; in other words, three discrepancies showed worse results than the actual data.

Next of the 16 so-called "discrepancies," seven of these items were not discussed or reviewed with our representatives. As I recall the GAO states in the report that it did not have time; or time did not permit or something to that effect, but they were not even discussed with us, so we do not know really anything about what the problem is on them.

Next, the GAO report does not identify the size or importance or relative importance of these alleged discrepancies. During the examination of the test data, we, in fact our engineers who were working with it did in fact observe many "deviations" being noted by GAO which were less than 1 percent.

Finally, the stop times of our qualification report for the five overload stops were taken from a digital tape record. The results of this test are simultaneously recorded by two different methods—one is a digital or computer produced record. The other is a record visually interpreted by the laboratory operator. Whenever these two records of this test are at variance, the computer produced record is accepted. This is our practice, and this is what we did in this instance.

Now there would be discrepancies between the two records, and in those cases we accepted the computer produced record.

In the opinion of our engineers, and I can assure you that in view of the charges made here this matter has been reviewed thoroughly, the data and the entire subject by our aircraft brake engineers at our Troy plant, and it is their opinion that none of the foregoing criticisms are relevant or significant as to whether the brake was or was not qualified.

Accusation by Senator Proxmire

Now as to the accusations of the Chairman in the statement which he released, I think in view of that statement it is most—well, the statement charged us with falsifying test reports to hide defects in brakes which we had made for this A7D attack plane.

We think it most significant that the GAO report, contrary to the Senator's statement, does not even suggest that test records were falsified.

Now I have read the report a number of times and I have not yet, Senator, found that accusation in it. I have found the section about discrepancies, which I have just finished discussing.

B. F. Goodrich emphatically denies that any test data relating to the A7D four-rotor brake were in any respect falsified.

The Air Force has mentioned here, and I am sorry I did not get all their names, so I will refer to the group, that some data in the report which was presented, did not meet some of the specifications. It must be obvious that these data were not changed so as to make it look like the brake was qualified.

We have presented data which the Air Force says did not meet some of the specifications.

As has already been shown, the field test problems encountered by the four-rotor brake were wholly unrelated to the question of whether the test data on the four-rotor brake were or were not changed.

This entire controversy in our opinion, if I may respectfully say so, completely overlooks the fact that judgments based upon years of professional training and experience are required in the interpretation and evaluation of test data. And I do not mean by this whether a thermometer reads 98 or 108, I am talking about an interpretation and an evaluation of this entire mass of test data, and in arriving at a judgment, a professional decision as to whether this brake qualifies under the test procedures prescribed by the contract. That is what I am talking about.

Judgments must be made to reach reasonable conclusions regarding the likely performance or the product being tested. Test data were not changed or falsified, but in interpreting and evaluating the data the project design engineer arrived at judgments as to the reasonableness and validity of the test results.

This is opinion, based not only upon data but also upon professional training and experience, and may result and in fact I am sure it did, in a rejection of some data in arriving at conclusions.

Obviously, we are talking about something quite different from changing or falsifying data.

As has been said, the judgments of our engineers were correct, because tests we were told—were instructed—to run under a contract would not have produced the problem which arose and there was not any other problem with this brake.

In Senator Proxmire's press release of this past August 4, it was said to have been based upon statements made by a technical writer who formerly was employed by B. F. Goodrich and who left our employ in October 1968. At the outset it should be understood that the technical writer is a high school graduate with no professional training.

Now while we are on that subject, I was informed by our people that Mr. Vandivier was in fact a high school graduate, and he so testified here two or three times, but his application for employment written in his handwriting shows that he attended high school for 2 years, September whatever the date is 1941 to 1943, and under "graduated" the word "no."

For the record just to keep it straight I think I will leave a Xeroxed copy of that employment report.

(The document follows:)

The B.F.Goodrich Company 1-28-63

APPLICATION FOR EMPLOYMENT

Before Acceptance as an Employee Every Applicant Must Pass a Physical Examination & Reference Check Satisfactory to the Company.

Date December 5, 1962

Name Vandivier (Last) Kermit (First) Wilson (Middle) (Maiden)

Social Security No. 305-24-2695

Present Address (Street) (City) (State)

Telephone No.

Home Address R.R. 2. (Street) Clinton. (City) Indiana (State)

Telephone No. Te-2-8936

For what positions are you applying? 1. 2.

Have you previously applied here? No

When could you report for work? Jan 1, 1963

State who referred you to us for employment: Capitol Placement Service

Were you ever employed by B.F.Goodrich? If so, when and where? No

Personal Information

Date of Birth Mo.	Day	Year	Sex	Height	Weight	Single, Engaged, Married, Divorced, Separated, Widowed?	How many children	Total dependents	Do you own or rent your home? Or board?	Do you own furniture?
11	2	1926	M	6'1½"	210	Married	6	7	Rent	Yes

Amount of life insurance you carry: 5,000

Own a car? Yes Make? Plymouth Year? 1956

Are you a U.S. citizen? Yes

Have you ever been refused bond? No When? By whom?

Name of husband or wife: Esther M. Vandivier

Where employed?

Do you now have or have you ever had any physical or health defects? Write yes or no: No

If yes, describe fully:

Have you ever filed a claim or received payment for temporary or permanent disability as a result of previous employment or military service? Write yes or no: No

If yes, describe fully:

Have you ever been arrested? (Other than minor traffic violations) No

If yes, state when / Where / Violation

To what organizations do you belong? (Other than religious, racial, or foreign national)

Education

	Name and Address of School	Dates From Mo. Yr.	To Mo. Yr.	Graduated Yes No	Degree Received	Major	Point Average or Rank in Class
High School	Wiley High School, Terre Haute, Indiana	Jan 1941	June 1943	No		Math	
College							
Graduate School							
Other	Port Arthur College, Port Arthur Texas	July 1946	Dec 1946	—		Radio	

How did you finance your college education?

Thesis subject:

Professor:

List extra-curricular activities in high school and college. Show offices held.

Sports

Journalism

With what foreign languages are you familiar: Check below: Speak / Read / Write

Publications:

Scholarships, Fellowships, Honors:

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Mr. JETER. This technical writer told the Senator that he had written in the report that A–7D four-rotor brake was not qualified, and that someone changed the statement to read that it was qualified.

If the Senator had inquired of us, which he did not, we would have told him that the sentence of the report referred to was changed as stated. The change was made by the senior project engineer who was responsible for the ultimate decision as to whether in the light of the test results, as prescribed by the contract, the specifications, and the views of LTV, the brake did or did not qualify.

This senior engineer was of course professionally trained, and through his discussions from day to day with the LTV engineers regarding test results, knew that they had accepted the tests.

Now this, of course, Mr. Vandivier knew nothing whatsoever about. He had nothing to do with contacting the LTV engineer who was on the job watching the day-to-day progress.

Those discussions were held between the senior project engineer and the LTV engineer.

Furthermore, the ultimate decision as to whether the brake was qualified obviously could not be made and should not be made by a technical writer with no professional training.

The conclusion of qualification of the brake was later formally approved by LTV.

Mr. Lawson, who testified here this morning, apparently disagreed with the conclusion that this brake qualified. I may say for your information and for whatever it is worth that Mr. Lawson is an engineer and was an engineer, but this was in fact, so I am told, the first airplane brake upon which he had ever worked. He had come to us, to our employment just shortly before, and the decisions with respect to this brake were in fact made by the project engineer, Mr. Warren, who was directly in charge of this project.

The source of the accusations that the company's records were falsified is the technical writer who was a former employee of our company. It has not been easy to find someone who would give any credence to his bizarre tale of the falsification of records.

In the fall of 1968 he attempted unsuccessfully to peddle this story to his employer, the Troy Daily News. He next reviewed his accusations with a lawyer. From there he went to the FBI and then on to the General Accounting Office.

Failing to interest any of this impressive group, including two Federal agencies, he then broadcast his tale to the newspapers and magazines throughout the country according to a quote of him in a newspaper the other day.

Significantly, we think, the first public notice given to the story was in the statement of Senator Proxmire on August 4, 1969.

CONCLUSION

In conclusion I want to say that on the record it has been established that B. F. Goodrich at a reasonable cost, and without any delay in the Air Force schedule, produced a brake for the A–7D, the performance of which exceeded the aircraft requirements. Throughout the entire program there were no safety incidents related to either the 4- or 5-rotor brake.

Further the GAO after an intensive examination, and we think it was intensive, has found no evidence of any change or falsification of any data.

Upon that record, we emphatically urge that there be an end to this wholly unjustifiable pointless attack through releases in the national press and congressional hearings which can only be harmful to the fine reputation enjoyed by our company.

Now that concludes my statement. I have Mr. Sink with me. I would like to ask him if time permits, Mr. Chairman, to comment on three or four items very briefly, if I may do that.

Chairman PROXMIRE. Very good. Time is getting along but I think that is only fair.

Mr. Sink, you go right ahead.

Mr. JETER. Mr. Sink, you have been referred to in the testimony here this morning by I think both Mr. Vandivier and Mr. Lawson.

Did you tell either Mr. Vandivier or Mr. Lawson to make any changes in the report as they were writing the report?

Mr. SINK. During the time that this report was written, I was on the west coast supervising the certification tests on the 727-200 aircraft. That was during the months of April, May, June and up to the early part of July. I had reviewed some of this data prior to leaving for the desert, but it had not gotten into report form yet.

Mr. JETER. Who, in fact, would have directly supervised the writing of this report during this period that you were away?

Mr. SINK. In my absence John Warren, the senior project engineer assumed this duty.

Mr. JETER. Rerefence has been made, Mr. Sink to a photograph, and mention I think if I understood it of an extra pressure disk or somethink, whatever that statement was. Would you just comment on that briefly?

Mr. SINK. Yes, sir. In the Mil Spec, the purpose of the worn-brake RTO, as Mr. Tremblay has told you, is one for information only. Also, as has been stated, prior to putting in the pressure plate, we actually had a spacer prior to the 45 stop condition. This also is well known. The pressure plate was put in so that adjusters could be installed and the correct pressures run for this RTO stop.

As far as our ability to evaluate the heat stack for its capability to conduct an RTO, it did not change in one way the capability of the brake to demonstrate performance.

Mr. JETER. Were adjustments made in the data to make—in the report I mean of the data, to make the brake look better than it really was?

Mr. SINK. Yes, sir; but not to make it look better. If I may ask the Senator a question concerning——

Chairman PROXMIRE. This is unusual procedure, Mr. Jeter.

Mr. JETER. Yes, you are getting a little bit out of bounds.

Chairman PROXMIRE. I will be happy to let you do it, and if you want to ask me a question I will be happy to reply.

Mr. SINK. Fine, thank you, sir.

Mr. JETER. I did not suggest this, Senator, I assure you.

Chairman PROXMIRE. Perfectly all right.

Mr. SINK. The submission that I believe was made earlier contains several of these changes which were made, and which were reviewed by the GAO. One of these changes that was made, of course, is that on the overload stops, the pressure was run at approximately 850 p.s.i. In the report you will see that this has been corrected to show the correct pressure to compensate for the adjusters which were not present during the overload stops, and what this would show is what the correct pressure would have been if the adjuster pressure were compensated for.

Another example is on the 45-stop condition stop time, and the 5-stop condition stop time. When the original copy of the report was submitted to engineering, Mr. Warren determined from the data presented that the stop times which were taken from the dynamometer log sheet and the torque traces, which were shown to represent the torque curve, did not coincide. There was a difference in stop time. Mr. Warren had a torque trace plot made from the digital data, and he determined from this what the actual stop time was, and informed LTV of these stop times, since they were longer than the specification stop time allowance.

It is our understanding that LTV in turn discussed these stop times with the Air Force, and that LTV told us that these stop times were acceptable, to present them as we got them off the digital data and they would be acceptable to LTV. They subsequently did approve the report.

Now we also found an example in this report where after going over the report in the July 27, 1968, session, to see how the raw data checked actually with the report, we found that at stop 33 of the tire change, that thermocouples for the fuse plug, bead seat, and tube well were interchanged on the slipring and what we detected up to stop 33 they had been reading in order: tube well bead, seat, fuse plug. We found after stop 33 they were reading in sequence bead seat, fuse plug, tube well.

Mr. Jeter. These two readings, I do not understand this myself.

Mr. Sink. In this situation what I am pointing out——

Mr. Jeter. The reading before and the reading after, were they near one another or quite different? This is what the Senator and the Congressman would like to know.

Mr. Sink. Yes, sir. We determined from this that here was another case where we should have changed the data from the raw data that was presented because it was perfectly obvious that when you have temperatures running in a sequence, during parts of the test they are not going to just arbitrarily change and run in a completely different sequence from one stop to the next. So there were areas where we should have changed the data in the report from the raw data, but we missed it due to the relative unimportance of these temperatures compared to other data that we did observe more closely.

Mr. Jeter. Does that answer your question? You might say a word about comparison, for example, of brake design program for an aircraft for a military fighter plane as compared with the design of an aircraft brake for——

Chairman Proxmire. Will this be the last?

Mr. Jeter. Yes, sir; it will, Mr. Chairman.

For a commercial plane?

Mr. Sink. Brakes for commercial aircraft are designed like work horses, since these things perform many stops every day, day in day out service accumulating many stops in a very short period of time. There is a lot of beef in them. They are the—well, work horse is a good comparison.

The fighter aircraft, by comparison to this, is more like a thoroughbred horse. It is skinned down. There is not an ounce of excess weight in it. It is very high performance, and as a result of this, the development program required to develop these fighter plane brakes is much longer than it is for commercial brakes.

Mr. JETER. Let me say only one word, Mr. Chairman, if I may.

I understand quite well, I think, that the Chairman and members of this committee are concerned and should be concerned that the Government gets and obtains good products when it is required to buy them, and that it buy these products at a reasonable cost. This is a very proper concern of this committee, and I understand that.

I do want the committee to understand likewise that we at the B. F. Goodrich Co. have this same concern, identical concern. We are in this business. We are very big at it. We hope to continue in it for, well, more years than I can say, and we do not know of any way to continue in it and be successful and be one of the major producers and suppliers in the world than to produce quality products at reasonable prices. There is not any other answer, because this is a competitive field.

I do want to thank you, Mr. Chairman, and Mr. Conable, for your attention to our statement.

Chairman PROXMIRE. I want to thank you, Mr. Jeter and Mr. Sink. It is a vigorous, forthright statement. There is no question where you stand on this and it is very helpful.

At the same time, just to take up what you have said, I think I would not be a responsible member of the Senate if two men coming to me as these two men did with what I thought was a sincere effort to express their concern about this very serious matter and told a story that sounded plausible, if I had not asked that an investigation be made. I did that.

The GAO made an investigation. You and I differ very much on what the GAO said.

Let me just start with that.

You say in your statement that, "The GAO report does not even suggest that test reports were falsified." Well, falsified is a word of intent which I am sure the GAO and everybody else is very careful about using. I did use it frankly in my release.

We did have testimony by the GAO engineer this morning and he told us that data did not show an honest picture.

Now——

Mr. JETER. If I may interrupt.

Chairman PROXMIRE. Yes, sir.

Mr. JETER. This is something he has added since the report was written.

Chairman PROXMIRE. Well, yes.

Mr. JETER. OK.

Chairman PROXMIRE. As I say, when I asked the GAO to conduct an investigation of this, I did not anticipate that they would come in, and they never do come in, and make charges that somebody is lying or that kind of thing. They do their best to find out what the facts are with relation to the data, with the substantive data which is being considered whether it is accurate or inaccurate, so that when I asked them whether this was an honest picture or not, I think that their answer to me satisfied me in that regard. But I think that you and I could talk, argue all day about whether this was falsification or whether it was a discrepancy that cannot be so categorized.

Mr. JETER. Let me say I am not to any degree whatever questioning the chairman's motives. I want to make that clear.

Chairman PROXMIRE. All right.

Now let me ask you this. Professional engineer opinon has been unanimous, designer Searle Lawson, your employee, Air Force engineer expert, Bruce Tremblay, and GAO engineer, Guy Best, have all testified this morning that the engineering practices at B. F. Goodrich in qualifying the four-rotor A7D brake was unacceptable. In fact, each of these gentlemen has testified this morning that Goodrich is still making questionable statements about the AD–7 four-rotor brake, this morning, for example, from your statement. You say, "It has never been determined whether the knitting problem resulted from brake design or was because of incompatibility between the brake and associated parts of the braking system."

As I recall, Mr. Best said that he was not sure on the basis of the data he had that he could make an assertion on that. The other two men were emphatic in saying that the knitting problem did result from the brake design.

Then in the second place they all testified where you say it is most significant "that the four-rotor brake knitting problem referred to above could not have been predicted from the indoor laboratory tests which the contract required regardless of how precisely these tests may have been performed." There again they disagree and their disagreement seems to be one of impressive unanimity.

Mr. JETER. The record will show, Mr. Chairman, but I think they testified as a general proposition and without any reference to the tests prescribed by the contract.

Chairman PROXMIRE. And then that they also testified where you say, "It was the judgement of the responsible B. F. Goodrich aircraft brake engineers at that time four-rotor brake satisfactorily performed the indoor tests and was ready for field testing on the AD7," they disputed this.

Mr. JETER. Yes, sir.

Chairman PROXMIRE. So that the experts that we have here disagree with you. Now let me ask you did B. F. Goodrich personnel add a spacer to the brake that was undergoing qualification tests? Did you testify that they did?

Mr. JETER. I am sorry, I did not hear the question.

Chairman PROXMIRE. You testified on this picture.

Mr. JETER. Yes sir.

Chairman PROXMIRE. On the basis of that picture and the other testimony I am asking you did B. F. Goodrich personnel add a spacer to the brake that was undergoing qualification tests?

Mr. SINK. Yes.

Chairman PROXMIRE. And that to assure that the brake would not run out of piston travel during the tests?

Mr. SINK. Yes, sir.

Chairman PROXMIRE. Didn't the other engineer say that that was unacceptable?

Mr. SINK. The other engineer was not in a position to know whether it was acceptable or not, Senator. In fact, I think if you will look again at the——

Chairman PROXMIRE. When you say the other engineer you are referring to Mr. Lawson?

Mr. SINK. Yes, sir.

Chairman PROXMIRE. Why wasn't he in a position to know? He was the employee of Goodrich. You gentlemen hired him and you gave him this assignment. It was your responsibility to put a competent man on it.

Mr. SINK. This is true, and he was a new engineer. We did try to give him guidance, but he preferred to have his own convictions.

Chairman PROXMIRE. You did try to give him guidance but he preferred to have his own convictions?

Mr. SINK. Yes, sir.

Chairman PROXMIRE. An interesting response.

Mr. JETER. I think it is quite understandable if I may say so, Mr. Chairman. He is a new employee. This is the first brake he has worked on. He is directly supervised by Mr. Warren, who is a very experienced design engineer, who has been with our company many years and designed many, many brakes.

I cannot believe this young man knew everything there was to know about brakes, and I am not criticizing him.

Chairman PROXMIRE. Nevertheless, it was testified by the other independent experts that the insertion of this kind of a spacer was not acceptable. Do you feel that those men are not qualified?

Mr. SINK. As pointed out under item 2 under a spacer——

Mr. JETER. You are referring to what?

Chairman PROXMIRE. The spacer you have in that picture in front of you.

Mr. SINK. I am referring to what I assume was introduced earlier. It says following the overall stops the stack deflections was eight hundred fifty-nine one-thousandths and the minimum travel allowable, the maximum to be more than this but the minimum with all the tolerances was eight hundred eighty one-thousandths which says had there not been a spacer in there the piston still would not have bottomed.

We had gone through the 45-stop test and this takes quite a while to do. We wanted to assure ourselves that the pistons would not bottom-out, and discontinued the test on this heat sink that had the 45 stops so the spacer was put in as a precautionary measure.

Chairman PROXMIRE. Now that the Air Force has indicated this is not acceptable you continue to test your brakes this way?

Mr. SINK. If we had the same situation come up today I believe the thing we should probably have done was to go back to LTV and let them go to the Air Force to have the Air Force witness this test.

I believe under these conditions that this procedure would be approved if it were properly handled beforehand.

Chairman PROXMIRE. Was in fact the wheel allowed to coast to a stop as indicated by GAO and confirmed by Mr. Vandivier's testimony this morning?

Mr. SINK. Yes, sir.

Chairman PROXMIRE. It was?

Mr. SINK. Yes.

Chairman PROXMIRE. And is this, Mr. Sink, a standard test procedure in the B. F. Goodrich, Troy, Ohio field and brake plant?

Mr. SINK. This is a common procedure. I would not say it is a standard procedure. It is a common procedure, and it has precedence in that this procedure was used for the qualification of military brakes when Wright Field was qualifying military brakes in that facility.

Chairman PROXMIRE. Didn't the Air Force say that this is unacceptable as quoted in the GAO report?

Mr. SINK. I have heard that this has been quoted in that report.

Chairman PROXMIRE. Once again, here is the same kind of a problem. The Government experts who testified to us tell us that this is not an acceptable procedure to give valid results.

Mr. SINK. But our contracting agency, sir, is LTV, and we discussed this procedure with LTV engineering and they approved this procedure prior to our conducting these tests.

Chairman PROXMIRE. You have a responsibility, I am sure both of you gentlemen are very honorable gentlemen, you recognize you have a responsibility to the Federal Government, too.

Mr. SINK. Yes, sir.

Chairman PROXMIRE. You are producing a plane, a product ultimately to be used as a U.S. plane, and in view of the fact that the policies adopted by the Air Force, which is the ultimate customer, seem to contradict your position, it would seem to me that that would govern rather than any negotiations or any agreement you might make with the contractor.

Mr. SINK. It is always the function of the contracting agency to set up the requirements for the design and qualification of a brake, and where the contractor has set up these requirements, these take precedence in many or most cases over the military specification.

Chairman PROXMIRE. Mr. Vandivier has testified before this committee that there are more than 80 falsifications of data in the Report 26031. He and others that are or were employed by B. F. Goodrich wheel and brake plant in Troy contend that they were coerced by their superiors into writing a distorted qualification report. Would you agree that there is misinformation in this report?

Mr. SINK. I would say that the information that is in the report presents a fair analysis of the performance of the 4-rotor brake during the qualification testing. There have been changes made in the data as we have noted before, but only to make them more consistent with the overall picture of the data that is available.

Chairman PROXMIRE. You stand alone in making that assertion. No other witness has indicated that. Certainly the GAO did not indicate it, the Air Force did not indicate it, neither did of course Mr. Lawson who is the engineer directly working on this project. Why do you need a 5-rotor brake if this is the case?

If this 4-rotor brake is qualified, why did you have to go to the trouble and expense to yourself of the 5-rotor brake?

Mr. JETER. Let me answer, Mr. Chairman.

When you say this brake, the 4-rotor, 5-rotor or whatever, is qualified, when we say this in our report, which we did, to the prime contractor, we are not saying this brake will fly on an airplane. We have not flown it on an airplane. We are saying that this brake is qualified under the specifications and tests prescribed by the contract, period, the indoor tests prescribed by the contract. We cannot state that the brake will pass flight test.

Let me say just this about this whole subject. If this science were such an exact science that we could design and produce a brake with or without, say with laboratory tests, and this brake will perform on an airplane exactly as it is supposed to, then there would be an absolute waste of money to conduct these flight tests, and they conducted almost 300 of them here, an absolute waste of money to conduct the tests. You just put them on the plane and fly it.

Chairman PROXMIRE. With all due respect——

Mr. JETER. I mean why do you have the flight tests?

Chairman PROXMIRE. Why did you change the design? Why did you go from a 4-rotor brake to a 5-rotor brake if the 4-rotor brake met the qualifications?

Mr. JETER. Well, the problem developed in flight. What I am trying to say to you is that we said the brake qualified on the basis of the laboratory test prescribed for us by the contract, and we do not certify to another thing. We cannot. We have not even had the brake working in conjunction with the rest of the braking system. We have not even seen that happen.

All we can certify to, and I think this ought to be clear, is that on the basis of the tests prescribed by our contract, the laboratory tests prescribed by our contract, we think the brake is qualified. It meets the qualifications as shown by laboratory tests, not flight tests if you please.

Chairman PROXMIRE. Now you have changed your method of testing between the four- and five-rotor procedure. You stated, "This problem is that the brake linings knitted or fused slightly at low speeds."

Then you say, "It has never been determined whether the knitting problem resulted from the brake design or was because of an incompatibility between the brake and its associated part of the braking system."

Then you say—this is with regard to the five-rotor—"Special laboratory tests were performed with the system in order to simulate the knitting problem."

So you obviously felt that the first tests were inadequate in that regard, because you used a new test procedure which you have testified with great emphasis in your view, although others seem to disagree——

Mr. JETER. I do not think anyone has disagreed with what I say on that subject if I may say so, Mr. Chairman.

Chairman PROXMIRE. Mr. Lawson flatly disagreed. I asked him that question.

Mr. JETER. Mr. Lawson, I do not think, addressed himself to the fact. If I may disagree with you, I do not think the record will show that anyone in this room today except myself has testified with respect to the fact that we obtained from LTV the complete braking system, and that we designed special tests with the entire braking system to try to produce this knitting or sticking or whatever you want to call it, and we did that in an effort to determine, Mr. Chairman, whether we could get a different composition, a different brake band that would in fact work in this four-rotor brake and would eliminate this knitting problem, but no one else has testified about this that I have heard.

Chairman PROXMIRE. Mr. Jeter, I have here documentation from your own plant signed by Mr. Gloor, the engineer, who says—

> Following stop number 49 the fuse plug material melted entirely.

It goes on to say—

> Brake pressure was released on the brake when the velocity reached 10 to 15 miles per hour. The following abnormal procedures occurred. Stators numbers 1 and 3 were physically switched after stop number 30 and remained in those positions to the conclusion of the test. Of the 5 overload stops were conducted with a lining carrier placed between the housing and the pressure plate.

and so on.

And he concludes as follows:

> In view of the aforementioned it is the writer's opinion that subject brake assembly is not a fully-qualified item.

This is another expert engineer, your Goodrich engineer. Now would you say that your Mr. Gloor is incompetent, not qualified?

Mr. JETER. I will ask Mr. Sink. I do not know Mr. Gloor.

Mr. SINK. Here again Mr. Gloor had just joined our organization, and he had joined the A–7D as test engineer taking over from who had carried it through the early development, so he had only been with us a very few months, and had no wheel and brake test experience at all prior to starting into the A–7D program.

Chairman PROXMIRE. What was this man's qualifications, this Mr. Gloor, who along with Mr. Lawson had responsibility in this area?

Mr. SINK. To the best of my knowledge he has been an instrumentation engineer at McDonnell.

Mr. JETER. Where?

Mr. SINK. McDonnell.

Mr. JETER. McDonnell Aircraft.

Chairman PROXMIRE. He is another independent engineer, independent in the sense he was newly hired. He worked for you—was employed by you. You are hiring people who appear to be incompetent on the basis of your testimony here.

Mr. JETER. "Inexperienced," if I may substitute a word for you, Mr. Chairman. If a new man is ever going to be hired, he has to be hired inexperienced, and I do not see any carelessness in hiring people because they have never had experience. The question is whether you give them adequate supervision until they get the experience.

Chairman PROXMIRE. Isn't it true that the instrumentation which is where Mr. Gloor had his experience, the instrumentation went wrong?

Mr. SINK. I do not know whether you could say it went wrong. It was a matter of interpreting what came off of it.

Chairman PROXMIRE. In this area Mr. Gloor should be qualified.

Mr. SINK. When you take data from several different sources, you have to rationalize among these data what is the true story. This is part of your engineering know-how.

Chairman PROXMIRE. What was that again, you have to rationalize data?

Mr. SINK. You have to look at the data rationally from experience and make an engineering judgment as to which——

Chairman PROXMIRE. You did not say look at the data rationally. In the first place you said rationalize.

Mr. SINK. This is a play on words.

Chairman PROXMIRE. All right, sir. Why do you believe that Mr. Vandivier and Mr. Lawson have come before this committee to tell us their part in the inclusion of this information in the qualification reports. I believe there are some inexplicable aspects of this thing of the one we all agree that Goodrich has nothing to gain by this, and I am sure that your motives, Mr. Jeter, and the motives of the other officials have been good.

On the other hand, the only logical explanation that I have heard of this whole incident was given by Mr. Vandivier when he said that pride or an attempt to hide a mistake or to save face seems to be the answer, and I can understand that.

On the other hand, I can throw right back at you why would these men come before us to make this testimony? Certainly Mr. Lawson has not anything to gain by this. He is in the industry now. He can be blackballed. He can be hurt badly.

Mr. JETER. Well, I am not going to question their motives either, but I will answer your question, and not question their motives.

I do not know either man. I saw them here for the first time in my life so far as I know, so I guess I must assume that they sincerely believe what they say.

I think that Mr. Vandivier is talking about some subjects and writing an opinion about a qualification which he was not at all qualified to do.

Chairman PROXMIRE. He was your technical writer. He worked for you for 3 years as a technical writer. He had written over 100 reports.

Mr. JETER. It is one thing to write down and record a lot of data results which you can read. I mean I can read temperatures myself. I am not an engineer, and this and that. And it is something else to arrive at conclusions as to which data is most significant and which is not. Where two tests are made simultaneously and they are at variance, it is an engineering judgment matter as to which one should be accepted, and when you look at this overall thing in the report, I did not bring it here, the report that we are talking about, that we made to LTV is this thick; two and a half inches thick. It is certainly an engineering matter requiring judgment to study, go over that report and decide whether the ultimate decision is that the brake is qualified or is not qualified, and I say this unequivocally, this technical writer is not qualified to make that conclusion from a report.

Chairman PROXMIRE. Yes, but you see, Mr. Jeter, we do not have a problem of a man who is just unqualified; an engineer who is inexperienced making some mistakes. We have men who have come before this committee and testified that they falsified, that they manufactured this data, that it was not true and they were told to qualify the brake and shut up about it, and so they followed those instructions. That was their testimony.

Mr. JETER. Well, they in fact were not so instructed. At least we have not been able to find—I can assure you that a very thorough investigation was made of this entire subject long before, I am sure, you heard of it, and we have yet to find man one who supports that statement which they make.

Chairman PROXMIRE. We have had man one and man two tell us that that is the case.

Mr. JETER. Yes.

Chairman PROXMIRE. And Mr. Gloor says it——

Mr. JETER. I told you we have 30-odd engineers at this plant, and most of them very experienced and very knowledgeable, and I say to you it is incredible that these men would stand idly by and see reports changed or falsified or whatever word you want to use when they have knowledge of it and they are responsible engineers. I mean you just do not have to do that working for anybody. I think you understand that and especially if you are a qualified engineer in some specialty such as the design and testing of brakes. Just nobody does that.

Chairman PROXMIRE. Finally, I would just like to ask you why after the GAO investigation did GAO recommend changes in the Government's responsibility for brake testing procedures, if the procedures were all right, and why in fact has there been an actual change in procedure in the Dayton, Ohio area where the Troy Wheel and Brake Plant is located? As I understand before this the four-rotor brake, for example, was tested as we have had testimony this morning, not in the presence of the Air Force and not in all cases in the presence of LTV.

On the other hand, the five-rotor brake has been tested in the presence of all the Air Force, LTV as well as——

Mr. JETER. Well, I want to make no defense of the test specifications prescribed by our contract, by LTV, and whether it should have been changed, or whether the GAO is right in suggesting that an Air Force man should be present. Maybe they are right in that recommendation. I am not quareling with it.

The Government, at least, would have somebody on the job seeing what is happening. We do not have any quarrel with it. They can have two there if they would like, but we did not design this program. We were given a contract and test procedures in it and that is it.

Chairman PROXMIRE. Mr. Conable?

Representative CONABLE. Thank you, Mr. Chairman.

Mr. Jeter, I have only one question and that relates to the interests of the Government in this affair.

Mr. JETER. Yes, sir.

Representative CONABLE. Can you give us an assurance that the Government will not at any time incur increased costs as a result of the necessary changes over from the four-rotor to the five-rotor brake? A statement was made here by the GAO that it was possible some of these additional costs could find their way into overhead, and that interested me because it would not be normally part of overhead.

Mr. JETER. Yes.

Representative CONABLE. And I just want to understand from your point of view, obviously your company has had some additional costs as a result of having to change.

Mr. JETER. Right.

Representative CONABLE. From a brake that had some flaws to one that is functioning properly?

Mr. JETER. Yes, we just designed two brakes and tested two instead of one for the same cost. This point or this mention in the GAO report

I have discussed with our engineers. I, of course, have no personal knowledge of it. I have discussed it with our engineers, and the head of our aerospace division in Akron, and I am assured that there was no additional cost to the Government in any form or manner whatsoever. There were no additional costs.

Representative CONABLE. Thank you.

That is all, Mr. Chairman.

Chairman PROXMIRE. Thank you, Congressman Conable.

And thank you, Mr. Jeter and Mr. Sink. I know this is a most unpleasant and a difficult job for all of us. You did a fine job and I appreciate the responsiveness you have given us.

Mr. JETER. Thank you very much.

Chairman PROXMIRE. The committee will stand adjourned.

(Whereupon, at 1:05 p.m. the Senate Subcommittee on Economy in Government of the Joint Economic Committee adjourned, to reconvene subject to the call of the Chair.)

34-919 O—70——20

APPENDIX

Review Of The Qualification Testing Of Brakes For The A-7D Aircraft

B-167023

Department of the Air Force
Department of the Navy
Defense Supply Agency

BY THE COMPTROLLER GENERAL OF THE UNITED STATES

COMPTROLLER GENERAL OF THE UNITED STATES
WASHINGTON, D.C. 20548

B-167023

Dear Senator Proxmire:

The accompanying report presents the results of our examination into the qualification of brakes furnished by The B. F. Goodrich Company to LTV Aerospace Corporation, a subsidiary of Ling-Temco-Vought, Inc., for use on the A-7D aircraft, as requested in your letter of May 13, 1969. The significant contents of this report are summarized in the digest included with the report. The review was made pursuant to the Budget and Accounting Act, 1921 (31 U.S.C. 53), and the Accounting and Auditing Act of 1950 (31 U.S.C. 67).

We did not submit copies of this report to the Department of Defense or the contractors, The B. F. Goodrich Company, and LTV Aerospace Corporation, Vought Aeronautics Division, for comment.

We plan to make no further distribution of this report unless copies are specifically requested, and then we shall make distribution only after your agreement has been obtained or public announcement has been made by you concerning the contents of the report.

Sincerely yours,

Elmer B. Staats

Comptroller General
of the United States

The Honorable William Proxmire
United States Senate

COMPTROLLER GENERAL'S REPORT TO THE HONORABLE WILLIAM PROXMIRE UNITED STATES SENATE

REVIEW OF THE QUALIFICATION TESTING OF BRAKES FOR THE A-7D AIRCRAFT
Department of the Air Force
Department of the Navy
Defense Supply Agency B-167023

D I G E S T

WHY THE REVIEW WAS MADE

At the request of Senator William Proxmire, the General Accounting Office (GAO) has reviewed certain aspects (see p. 2) of the qualification tests of brakes for the A-7D aircraft. These tests were performed by The B. F. Goodrich Company under a subcontract with LTV Aerospace Corporation, Vought Aeronautics Division (LTV/VAD), the prime contractor with the Navy for the A-7D aircraft to be used by the Air Force.

FINDINGS AND CONCLUSIONS

The results of GAO's review indicated that:

--in some instances Goodrich's test procedures for the four-rotor brake did not appear to comply with specification requirements or normal industry practice (see p. 6),

--Goodrich's qualification report on the results of testing the four-rotor brake contained some discrepancies that might be considered significant (see pp. 6 and 8),

--opinions differed as to the danger to the pilot and the potential damage to an aircraft due to brake failure. No significant aircraft damage due to the use of the four-rotor brake had been reported (see p. 10),

--Goodrich offered to, and did, replace the four-rotor brake with a new five-rotor brake without any apparent increase in cost to the prime contractor or the Government. We were advised that the change did not cause any delays in the delivery or testing of the aircraft (see pp. 12 and 13),

--the prime contractor's procedures and those of the Defense Contract Administration Services District (DCASD) were inadequate to protect the Government's interests in the qualification tests of the four-rotor brake (see p.13), and

--the Department of the Air Force protected the Government's interest by withholding approval of the qualification report (see p. 18).

C o n t e n t s

ABBREVIATIONS

DCASD	Defense Contract Administration Services District
ECP	Engineering change proposal
GAO	General Accounting Office
LTV/VAD	LTV Aerospace Corporation, Vought Aeronautics Division

COMPTROLLER GENERAL'S REPORT TO THE HONORABLE WILLIAM PROXMIRE UNITED STATES SENATE

REVIEW OF THE QUALIFICATION TESTING OF BRAKES FOR THE A-7D AIRCRAFT
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--the Department of the Air Force protected the Government's interest by withholding approval of the qualification report (see p. 18).

INTRODUCTION

The General Accounting Office, at the request of Senator William Proxmire, has examined into the qualification testing of the brake assemblies for the A-7D aircraft at The B. F. Goodrich Co., Troy, Ohio.

The Naval Air Systems Command is purchasing 74 A-7D aircraft for the Department of the Air Force under contract N00019-67-C-0143 with LTV Aerospace Corporation, Vought Aeronautics Division.

We were asked to inquire into whether (1) Goodrich's qualification report accurately presented the actual recorded test results, (2) the use of a defective brake endangered the test pilot's safety, and (3) the Government incurred additional costs due to the changes in the brake. In addition, we were requested to determine the Government's responsibilities in the qualification testing of the brakes and the Air Force's actions to protect the Government's interest. Additional information furnished by a member of the Senator's staff related the requested information to the four-rotor[1] brake assembly.

LTV/VAD solicited, and we were advised that they received, quotations from The B. F. Goodrich Co., Bendix Aviation Products Division, General Tire and Rubber Co., and Goodyear Aviation Products Division on various items, including the brakes, for the A-7D aircraft. LTV/VAD officials stated that The B. F. Goodrich Co., Aerospace and Defense Products Division, was selected on the basis of the price and technical design. LTV/VAD officials stated that the Air Force concurred in their selection. Thereafter, LTV/VAD issued a firm-fixed-price purchase order,

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[1] A rotor is a rotating metal disc interspersed with stators, which are stationary metal discs carrying brake lining material. The rotor and stator discs, when compressed, perform the braking action.

number P-237138, dated June 18, 1967, to Goodrich and supplements to this purchase order have been issued, exercising options granted to LTV/VAD by Goodrich in the basic purchase order, as follows:

Purchase order document	Date	Quantity of brake assemblies	Firm-fixed unit price	Total price
Basic	June 18, 1967	40	$364.50	$14,580
Supplement 2X	Mar. 20, 1968	160	338.50	54,160
Supplement 5X	Dec. 9, 1968	2	338.50	677
		202	343.64[a]	$69,417

[a]Weighted-average unit price.

Also, LTV/VAD exercised the 1969 option of the above purchase order through the issuance of purchase order P-354831, dated February 10, 1969, for 260 brake assemblies at $338 each, or a total of $87,880. On April 30, 1969, this purchase order was amended to increase the number from 260 to 267 brake assemblies at the same unit price for a total price of $90,246. These brake assemblies had been included in LTV/VAD's proposal to the Government at $343.70 per unit, excluding general and administrative expenses and a 7-percent factor for scrap and other miscellaneous costs, in determining the initial cost for contract -0143.

LTV/VAD initially purchased a four-rotor brake but, in January 1969, revised, in part, the purchase order to require five-rotor brake assemblies. The differences between the four- and five-rotor brake assemblies are as follows:

Part name	Four-rotor brake		Five-rotor brake	
	Part number	Quantity	Part number	Quantity
Rotor	134-44	4	134-49	5
Stator	244-270	3	244-306	4
End plate segments	244-271	28	244-307	28

The LTV/VAD purchase orders show that the following types of brake assemblies had been ordered:

LTV/VAD purchase order no.	Quantity of brake assemblies		Total
	Four-rotor	Five-rotor	
P-237138	46	156	202
P-354831	0	267	267
Total	46	423	469

LTV/VAD purchase order P-237138 required Goodrich to perform qualification testing on the brake assemblies and to submit a report on the results of such testing. The qualification tests are referred to as preproduction tests in the referenced specifications. Both LTV/VAD specification 204-16-37d and military specification MIL-W-5013G defined preproduction tests as tests conducted by the vendor on samples representative of the production item to ensure conformance with the specification requirements. Goodrich lawyers stated that the four-rotor brake assemblies subjected to qualification tests were hand made units, similar to brake assemblies to be manufactured, rather than production models.

Goodrich submitted to LTV/VAD its qualification test report, Q-6031 revision A, dated July 12, 1968, on the four-rotor brake assembly. This report was signed by a DCASD Dayton representative (see p. 16) and approved by LTV/VAD. However, the Air Force's Aeronautical Systems Division recommended withholding approval of the report. Subsequently, Goodrich proposed to supply a five-rotor brake as it did not believe that the four-rotor brake met their "suitable for the intended use" obligation to LTV/VAD and requested that LTV/VAD withdraw its approval of the four-rotor brake qualification test report.

Goodrich submitted the five-rotor brake assembly qualification test report, Q-6046 revision A, dated February 18, 1969. This report also was signed by the

DCASD Dayton representative (see pp. 16 and 17) and approved by LTV/VAD. We were advised, however, that, as of June 5, 1969, the Air Force's Aeronautical Systems Division had not approved Goodrich's qualification report on the five-rotor brake.

The scope of our review appears on page 20.

REVIEW OF QUALIFICATION TESTS OF BRAKES

VARIATIONS IN QUALIFICATION TESTING PROCEDURES AND RESULTS REPORTED

The results of our review indicated that, in some instances, Goodrich's qualification test procedures for the four-rotor brake did not appear to comply with the specification requirements or normal industry practices. Also, we found that Goodrich's qualification report data on the results of testing the four-rotor brake contained some discrepancies which, in the judgment of an engineer assigned to our staff, may be considered significant.

The qualification report and its supporting data were considered to be proprietary information by Goodrich, who requested that this information not be further disclosed. We have, therefore, omitted from our report the specific data obtained from Goodrich during this review.

Test procedures for the four-rotor brake

Qualification report Q-6031, which was applicable to the four-rotor brake, indicated that the tests adhered to the requirements of military specification MIL-W-5013G, except where the specification differed from the LTV/VAD specification. This report indicated also, that no deviations were requested by Goodrich.

However, Goodrich's project manager stated, and documents showed, that the brake pressure was released at 10 miles per hour and the wheel permitted to coast or taxi for 10 to 15 seconds. Military specifications required the brake to bring the wheel to rest.

Goodrich officials stated that, to compensate for the rolling stop, higher energy was imposed on the wheel at the higher speeds. Goodrich's project manager stated that LTV/VAD had orally approved this waiver to the test procedures and LTV/VAD officials acknowledged verbal approval of minor deviations to Goodrich's test procedures but did not describe to us the specific deviations. However, an Air Force engineer considered that the failure to come to a complete stop was unacceptable because torque stresses reach their peak during the 10 to 0 miles per hour velocity.

Goodrich's project manager advised us of the following test procedures which, he said, were orally approved by LTV/VAD.

1. Use of the 84-inch instead of 120-inch dynamometer for the 45 normal brake stop tests because Goodrich stated the larger dynamometer was, tied up, with other programs.

2. Use of a test sequence of 45 normal, 5 overload, and 2 rejected-take-off brake stop tests, although it was common industry practice to intersperse the normal and overload stop tests.

A Goodrich official informed us, and we verified the fact, that test sequence requirements were not specified in military specification MIL-W-5013G or LTV/VAD specification 204-16-37d. LTV/VAD officials advised us that they considered the significance of the test sequence a matter of opinion, but their Assistant Director for the A-7D program stated that he preferred an interspersed 9 normal to 1 overload stop test sequence. However, an Air Force engineer stated that any brake failure would disqualify the tests; and, in his opinion, had Goodrich performed the tests on the 9 to 1 interspersed basis, the brakes would not have lasted through the 50 normal and overload stop tests.

Goodrich's Special Test Requirement and Procedures and Operator's Comments set forth various other instructions or actions regarding the procedures or methods in the qualification testing. Among these was the statement that the stators were switched between the number 1 and number 3 positions and we selected this for further inquiry. Goodrich stated that this was a laboratory technique in which the results were studied by an engineer to determine the wear pattern of the linings on the stator.

Military specification MIL-W-5013G and LTV/VAD specification 204-16-37d are silent regarding the switching of parts or components. LTV/VAD officials, however, advised us that the switching of stator positions was not normal industry practice. In the opinion of an Air Force engineer, this switching of parts was unacceptable.

Reported test results on the four-rotor brake

We selected brake stop tests from qualification report Q-6031 for verification of the basic recorded test results. Each of these brake stop tests included the recording or measurement of 18 characteristics, or parameters, 16 of which were selected for verification. The extent and results of our verification were as follows:

	Stop tests				
		GAO sample		Discrepancies (note a)	
Test title	No. in universe	No.	Percent of universe	No.	Percent of sample
Normal brake stop	45	7	15.6%	2	28.6%
Overload brake stop	5	5	100.0	5	100.0
Worn brake rejected-take-off stop	2	2	100.0	2	100.0
Total stop tests	52				
Total GAO sample		14	26.9%	9	64.3%

[a]These are the discrepancies, existing in at least one or more of the 16 test characteristics or parameters in each of the stop tests, that may be considered significant.

The parameter discrepancies that may be considered significant between data shown in the test report (Q-6031) and data shown by Goodrich's test instruments, as well as Goodrich's explanations, are set forth in the exhibit of this report. In addition, we found other discrepancies which we considered to be insignificant because they were due to variations in engineering interpretations and transposition of the report data between stop tests.

On the two remaining parameters in our selected sample of 14 stop tests, we compared the reported data with the operator-recorded data and Goodrich's test requirements. We noted that reported and operator-recorded data on stop time were in agreement except on the five overload stop tests where reported data presented a lesser stop time than that of the operator-recorded data. A Goodrich project manager advised us, however, that LTV/VAD had orally accepted the five excessive overload stop times after the tests but prior to the issuance of the qualification report. In 12 instances the stop time reported was greater than Goodrich's test requirements. Limitations on our time for this review precluded our comparing the stop times to the basic recorded test results and discussion of the resulting discrepancies with a Goodrich engineer.

<u>Test procedures and reporting on the five-rotor brake</u>

We did not review the test procedures regarding the five-rotor brake or verify the resulting data contained in qualification report Q-6046 due to the limited time for our review. However, as discussed in subsequent report segments, LTV/VAD, Air Force, and DCASD representatives monitored, at least in part, Goodrich's performance of the testing and/or were provided access to the basic recorded test results.

INQUIRY INTO POSSIBILITY OF DANGER
TO PILOT AND AIRCRAFT DAMAGE

We found that there were differences in opinions on the danger to the pilot and potential damage to an aircraft due to brake failure but that no significant damage due to the use of the four-roter brake had been reported.

Air Force, Navy, and LTV/VAD officials generally agreed that the brakes did not endanger the life or safety of the test pilots. However, among these same officials, there was no definite consensus regarding the potential of damage to an aircraft, which may be incurred as the result of brake failure.

In response to our question regarding pilot safety and structural damage, Federal Aviation Administration officials stated that warping or welding of the brakes would blow out the tire, which in turn might cause (1) collapsing of the landing gear, (2) breaking of the hydraulic lines, and/or (3) puncturing of the gas tanks located in the aircraft wing. As the result, they further stated the most likely danger was a fire due to the combination of the heat in the brakes and leaking hydraulic fluid and/or jet fuel. They told us, however, that they did not have any accident investigation reports concerning such incidents.

Both contractor and military pilots conducted flights in the aircraft with four-rotor brakes prior to and after LTV/VAD's engineering approval of the qualification report. However, Air Force, Navy, and LTV/VAD officials advised us that there was no requirement for brake qualification prior to use on an aircraft. The following statistics on flights and brake problems were obtained from the contractor and military flight reports and/or flight discrepancy sheets.

34-919 O - 70 - 21

	Flights		
	Prior to LTV/VAD approval of qualification report	After LTV/VAD approval of qualification test and before installation of the five-rotor brake	Total
Number of flights:			
Contractor	37	192	229
Military	12	26	38
Total	49	218	267
Number of flights indicating potential brake problems (note a):			
Contractor	6	6	12
Military	0	0	0
Total	6	6	12

[a]The brake is used in conjunction with an anti-skid system. These reports describe other problems which the pilots appear to relate to this system.

Generally, the contractor noted brake problems were described in terms of the sensitivity of the brakes, which concerns the relationship between the brake pedal travel distance and the braking action. This problem was also reported in a military preliminary evaluation summary report. On only two contractor flight reports did we note any effect of the brakes on the aircraft. In one instance, the wheels locked up and, in the other instance, the brakes fuzed so that they had to be loosened with a screw driver. In addition, an LTV/VAD official stated that, in one other instance, the brakes fuzed as anticipated during a ground test.

Discussions with the contractor's test pilot who had flown the flights where the lock-up and fuzing occurred and with military test pilots indicated that they considered that there was no danger to the pilot and/or aircraft from the four-rotor brake performance.

Air Force and LTV/VAD officials stated that they were satisfied with the five-rotor brake although there were some minor problems with this brake.

NO ADDITIONAL COSTS INCURRED
DUE TO CHANGES IN THE BRAKE

We found no evidence of an increase in the costs to the Government or LTV/VAD for the replacement of the four-rotor brake assemblies with five-rotor assemblies or for the performance of the second qualification test.

A listing of the engineering change proposals (ECPs) was furnished to us by LTV/VAD officials as being those changes to the prime contract, where additional funds had been requested by LTV/VAD but had not been negotiated as of May 26, 1969. Our review of this listing did not identify any ECPs related to brake assemblies. Furthermore, LTV/VAD officials advised us that neither had there been nor did they contemplate any ECPs for the brake assemblies under the prime contract. Also, LTV/VAD and responsible Air Force officials stated that, to their knowledge, the prime contract price to the Government had not been increased because of the brake assemblies.

Goodrich offered to replace the four-rotor with five-rotor brake assemblies and to perform the new qualification tests at no cost to LTV/VAD or the Government.

We found that the price set forth in LTV/VAD's initial purchase order, P-237138, had not been revised except for exercising the options contained in the basic order for additional quantities at predetermined unit prices. Further, we did not find, in the purchase orders we reviewed, any other LTV/VAD purchase orders which provided Goodrich with compensation for modifying the brake assemblies or performing the second brake qualification test.

Our review of the receiving and shipping records furnished to us by LTV/VAD showed that 46 four-rotor brake assemblies were received but that three had been rejected during LTV/VAD's incoming inspection. We ascertained that, of the remaining 43 units, 33 had been exchanged for five-rotor brakes at no cost to LTV/VAD or the Government. LTV/VAD officials stated that they could not readily provide us with the status of the remaining units. They assured us, however, that all four-rotor brake assemblies received from Goodrich have been or will be returned for replacement with the latest brake configuration at no charge to LTV/VAD or the Government.

AIRCRAFT DELIVERY AND TESTING WERE NOT DELAYED BY BRAKE PROBLEMS

We were advised that problems encountered with the brakes did not affect aircraft delivery or testing. We discussed the effect of the brake problems on aircraft delivery and testing with an Air Force Aeronautical Systems Division engineer and LTV/VAD officials. They advised us that the brake problems had not delayed either delivery or testing of the aircraft.

WEAKNESS IN CONTRACT ADMINISTRATION PROCEDURES

We found that contract administration responsibilities had been assigned to LTV/VAD and DCASD. In our opinion, however, procedures of both were inadequate to protect the Government's interest in assuring that the qualification tests were properly performed and the results were correctly reported on the four-rotor brake.

Requirements of the Armed Services Procurement Regulation

According to Armed Services Procurement Regulation 14-102, the prime contractor is responsible for controlling product quality, including that at the subcontractor level, and for offering to the Government only those supplies or services which meet the contract requirements. This section provides, in addition, that the control of quality by the prime contractor may relate to, but is not limited to, testing and examination to ensure that practices and equipment provide the means for optimum evaluation of inspection characteristics.

Armed Services Procurement Regulation 14-103.1 and 14-407.1 provide for Government inspection, when deemed necessary, to assist the assigned contract administration office for the prime contract to determine whether the prime contractor is ensuring conformance of the subcontracted supplies or services with the contract requirements. They further provide that Government quality assurance actions at the subcontract level do not relieve the prime contractor of any responsibilities for subcontract administration.

Prime contractor's contract administration responsibilities

The prime contract assigned LTV/VAD the responsibility for ensuring that all supplies and services procured from the subcontractor conformed to contract requirements. However, the extent of control exercised by LTV/VAD was to be dependent upon the type of supplies purchased, the subcontractors' demonstrated capability, and quality evidence made available by the subcontractor. In addition, the prime contract reserved the right of Government inspection at the subcontractors' facilities.

LTV/VAD's purchase order P-237138 and the referenced LTV/VAD specification requirements for the qualification test included:

1. LTV/VAD's approval of Goodrich's qualification test procedures.

2. LTV/VAD's rights to witness the tests and to perform other tests to ensure a satisfactory product.

3. LTV/VAD's approval of the qualification test report.

4. Government inspection at Goodrich's plant.

5. Government inspector's signature on the qualification test report.

6. Government inspector's right to use drawings or other pertinent data required for adequate source inspection, available at the subcontractor's plant.

LTV/VAD officials stated that they relied upon Goodrich, whom they considered a responsible contractor, to satisfactorily perform the qualification tests on the four-rotor brake assemblies. LTV/VAD officials also stated that none of their engineers were brake experts. They stated, however, that LTV/VAD's representatives had witnessed some Goodrich tests on the four-rotor brakes, but that the tests witnessed were performed prior to normal, overload, and worn brake rejected-take-off stop tests supporting the qualification test report, Q-6031.

LTV/VAD officials stated that, prior to granting its approval of the four-rotor qualification test report, they reviewed only the data contained in the report and did not compare the reported data with the original recorded test results--hereafter referred to as raw data. LTV/VAD's approval of Goodrich's four-rotor qualification test report, Q-6031, was incorporated into LTV/VAD's purchase order P-237138 in supplement 4X, dated August 1, 1968, by reference to LTV/VAD's engineering order E 1001.770, signed July 16, 1968, by LTV/VAD officials. This engineering order also included LTV/VAD's approval of Goodrich's preproduction test plan for the four-rotor brake.

LTV/VAD officials stated that, after Goodrich refused the Air Force access to Goodrich's raw data supporting the four-rotor brake qualification report, a LTV/VAD representative was authorized to review this raw data. LTV/VAD's review in the fall of 1968 disclosed discrepancies in the qualification tests which were considered to be of such significance as to conclude that the four-rotor brake did not qualify to the "letter of the specification." Subsequently, Goodrich proposed to substitute a five-rotor for the four-rotor brake.

LTV/VAD officials stated that its representatives were present during the performance of the qualification tests on the five-rotor brakes. Approval of the five-rotor brake qualification report, Q-6046, was made by LTV/VAD's engineering order E1026.17, which was signed by LTV/VAD officials during February 1969 and incorporated in purchase order P-237138 by supplement 7X, dated April 9, 1969. In addition, LTV/VAD's engineering order E1026.17 canceled engineering order E1001.770 regarding approval of the four-rotor brakes and approved Goodrich's preproduction test plan for the five-rotor brake.

Government's contract administration responsibilities

The contract administration functions at LTV/VAD were assigned to the Naval Plant Representative Office located at the prime contractor's plant. Secondary delegations of quality assurance responsibility at Goodrich was assigned to DCASD Dayton, Ohio.

LTV/VAD's purchase order P-237138 provided for Government source inspection at Goodrich and the referenced LTV/VAD specification required the Government inspector to sign the qualification report without further describing the meaning or significance of such a signature. In our opinion, the affixing of a signature to a report is meaningless unless accompanied by some other act, such as verifying, at least on a test basis, the reported information to the original documents. We also believe that the report or document should contain a clear and concise statement as to the meaning of the signature to indicate the reliance that may be placed upon such actions by other readers.

The DCASD quality assurance representative stated that Goodrich required his signature on the qualification report because LTV/VAD would not accept it without his signature; however, he had not received any specific oral or written instructions from any Government activity or the prime contractor's officials as to what steps were to be taken prior to signing the four-rotor brake assembly qualification report, Q-6031. His signature was affixed to the Q-6031 report, in which it was concluded that the brake assembly met the intent and requirements of the applicable specification documents and therefore was qualified.

The quality assurance representative explained that he interpreted LTV/VAD's quality control requirements to mean an inspection of the qualification test report in the same manner as for any other hardware item, thus he assured himself that all the tests listed in the front of the report were accomplished and successful solely on the basis of the report contents. The quality assurance representative also stated that he did not witness any of the tests on the four-rotor brake or compare any raw data with the Q-6031 report and commented that this was DCASD's normal practice.

The Chief, Quality Assurance Section, DCASD Dayton, stated that the quality assurance representative's signature meant that he had compared, on a test basis, the raw data generated by the test recording machines with the information reported in the Q-6031 report and that the information was in agreement. He stated also that he had contacted Defense Contract Administration Services Region, Cleveland, for an interpretation of the signature on a qualification test report, but that they could not provide any assistance.

The DCASD quality assurance representative stated that he witnessed two of the qualification tests on the five-rotor brake at Goodrich. This qualification report, Q-6046, also was signed by the DCASD quality assurance representative.

Subsequent to our discussions, DCASD Dayton issued, basically, the following internal guidance to their quality assurance personnel:

1. Do not countersign qualification reports unless contractually required or unless directed by higher authority.

2. A signature constitutes verification of the data contained in the report and shall not necessarily indicate concurrence with the conclusions in the report.

3. When countersigning as authorized in 1. above, identify in the report the test data for the tests actually witnessed.

AIR FORCE ACTIONS TO PROTECT THE GOVERNMENT'S INTERESTS

We found that the Air Force took action to protect the Government's interest by withholding approval of the qualification test reports until assuring itself that the brake assembly either qualified or performed satisfactorily on the aircraft.

Air Force engineers advised us that the engineering responsibility for the A-7D Government-furnished aeronautical equipment and all contractor-furnished equipment was assigned to the Chief System Engineer in the Directorate of Systems Engineering, Aeronautical Systems Divison, Air Force Systems Command, Department of the Air Force. We were also, told that, within the Aeronautical Systems Division, the Project Engineer in the Landing Gear and Mechanical Equipment Division, Directorate of Airframe Subsystems Engineering, was responsible for reviewing and recommending approval of the design, development, and testing of the A-7D aircraft landing-gear equipment, including Goodrich's four- and five-rotor brakes.

The Project Engineer stated that he had reviewed and approved LTV/VAD's brake specifications which in his opinion were very good and exceeded the military specifications. The Project Engineer also stated that he had not witnessed any of the qualification tests of the four-rotor brake, and during August 1968 he recommended withholding approval of the qualification report, Q-6031. His recommendation was based on various specific irregularities noted during a review of the qualification report. This recommendation was forwarded by the Chief System Engineer to the Naval Air Systems Command, Washington, D.C.

The Project Engineer stated that he had requested Goodrich to furnish him with the raw data supporting its Q-6031 report during a meeting between Air Force, LTV/VAD, and Goodrich representatives in early October 1968. This request, he advised us, was not honored by Goodrich who claimed that the raw data was proprietary information.

Regarding proprietary information, attachment "E" to LTV/VAD purchase order P-237138 states that Goodrich reiterates it will provide all the data required by the prime contract pursuant to the provision of Armed Services Procurement Regulation 9-203(b). This provision sets forth the Government's "Rights in Technical Data" and provides, in part, for the Government's right of access to technical data resulting from the performance of an element of work specified in a Government contract or subcontract.

The Project Engineer stated that, during the October 1968 meeting he had advised Goodrich that he would not approve the use of the four-rotor brake assembly on the A-7D aircraft. Subsequently, during another meeting, LTV/VAD informed the Air Force engineers that Goodrich was redesigning the brake assembly and would requalify the new design.

The Project Engineer stated that he closely monitored the qualification testing of the five-rotor brakes, was provided access to the applicable raw data, and reviewed Goodrich's qualification test report, Q-6046, which he found to be satisfactory. However, because of reported problems with brake adjusters the Project Engineer, in April 1969, recommended withholding approval of Q-6046 until satisfactory performance on the aircraft was demonstrated. On June 5, 1969, the Project Engineer stated that he had not yet recommended approval of Q-6046.

SCOPE OF REVIEW

We reviewed records and discussed the performance and qualification testing of the brakes for the A-7D aircraft with officials at contractor locations and military installations associated with the design and manufacture, administration, and testing of these brakes. These locations include The B.F. Goodrich Co., Troy, Ohio; LTV Aerospace Corporation, Vought Aeronautics Division, Dallas, Texas; Naval Air Systems Command, Washington, D.C.; Naval Plant Representative Office, located at LTV/VAD, Dallas, Texas; and the Aeronautical Systems Division of the Air Force Systems Command, located in Washington, D.C., and at Wright-Patterson Air Force Base, Ohio.

In addition, we discussed brake performance with a LTV/VAD test pilot at the contractor's plant and with military test pilots located at Edwards Air Force Base, California, and Patuxent River Naval Air Station, Maryland, and with officials of the Federal Aviation Administration.

EXHIBIT

DATA DISCREPANCIES THAT MAY BE CONSIDERED SIGNIFICANT

BETWEEN DATA SHOWN IN TEST REPORT AND

DATA SHOWN BY GOODRICH'S TEST INSTRUMENTS

Data identified in test report		
Test description	Stop number	Parameter
Normal brake stops	4	Peak torque
Do.	25	do.
Overload brake stops	46	Peak temperature of tube well
Do.	46	Initial temperature of center stator
Do.	46	Peak temperature of center stator
Do.	47	" torque
Do.	47	" temperature of rotor
Do.	48	" " " bead seat

EXHIBIT
Page 1

Discription of discrepancy (note a)	Explanation by Goodrich's representatives
Reported data exceeded the basic recorded test results (analog data since digital data was not available).	Normally, digital recorded data exceeds analog readings. Therefore, using one's best judgment, a similar value from an earlier similar test would be used. In this instance, he felt, the reported value had been extrapolated from the preceding and subsequent stop test.
do.	The basic recorded value was taken from the prior stop test since the stop times were identical. This constitutes a "rationalization of data" or exercise of professional judgment.
Reported data less than the basic recorded test results.	Not discussed with Goodrich representatives due to the limited time for our review.
Data were reported; however, basic recorded tests results were not available.	Do.
do.	Do.
Reported and digital data in agreement; however, digital data less than analog data.	Do.
Reported data less than basic recorded test results.	Do.
Reported data less than basic recorded test results. We also noted that the reported data were less, and the recorded test results were greater, than requirements of MIL-W-5013G, dated February 20, 1967, which was referenced by LTV/VAD specification number 204-16-37d.	Goodrich personnel could give no explanation.

DATA DISCREPANCIES THAT MAY BE CONSIDERED SIGNIFICANT

BETWEEN DATA SHOWN IN TEST REPORT AND

DATA SHOWN BY GOODRICH'S TEST INSTRUMENTS

Data identified in test report		
Test description	Stop number	Parameter
Overload brake stops	49	Peak temperature of bead seat
Do.	49	" " " rotor
Do.	50	" " " bead seat
Do.	50	" " " tube well
Rejected take-off brake stops	1	" torque
Do.	2	Initial temperature of center stator
Do.	2	Peak temperature of center stator (note b)
Do.	2	" " " rotor (note b)

[a]Reported data are the elements set forth in qualification test report Q-6031 on the four-rotor brake. Basic recorded test results refer to digital data, which are digital printout tapes prepared only on brake pressure and torque parameters, and/or analog data, which are pen recorder strip charts prepared on all parameters.

[b]The Goodrich Project Manager stated that the peak temperatures reached during rejected take-off stop tests were academic since the brake is destroyed by heat as the result of the test.

EXHIBIT
Page 2

Description of discrepancy (note a)	Explanation by Goodrich's representatives
Reported data less than basic recorded test results. Also, reported and recorded data exceed the requirements of MIL-W-5013G, dated February 20, 1967.	Goodrich personnel could give no explanation.
Data were reported; however, basic recorded test results were not available.	No reading, due to the reaction of the thermocouple.
do.	The recorder was not working properly.
do.	Not discussed with Goodrich representatives due to the limited time for our review.
Reported data less than basic recorded test results.	Goodrich personnel could give no explanation.
Data were reported; however, basic recorded test results were not available.	Goodrich personnel expressed the opinion that the data had been rationalized from tests of another part on which the temperature had been monitored and which was considered comparable to the center stator.
do.	Do.
do.	Not discussed with Goodrich representatives due to the limited time for our review.

COPY

COMPTROLLER GENERAL OF THE UNITED STATES
WASHINGTON, D.C. 20548

July 11, 1969

B-167023

Dear Senator Proxmire:

This letter is an addendum to our report to you dated July 3, 1969, on the review of the qualification testing of brakes for the A-7D aircraft, and is in response to your further inquiry of July 9, 1969, and discussion with your staff on July 10, 1969.

As indicated in our report, there were discrepancies between the data shown in the B. F. Goodrich test report (Q-6031), and the data shown by its test instruments. In our examination we noted instances where data were reported notwithstanding the fact that none were available from the test instruments. In other instances we noted that reported data were at variance with recorded test results. In some instances B. F. Goodrich personnel could not offer an explanation, while in other instances the discrepancies were justified by what they consider "professional judgment."

In our opinion, the B. F. Goodrich Company should have accurately reported the test results in its report Q-6031. In the absence of accurately reported test results it is difficult, if not impossible, to properly evaluate product performance.

Although we have no firm evidence at this time, that the conditions noted with regard to the A-7D brake is widespread throughout the defense industry, we have previously programmed audit work in the area of quality assurance. Our audit staffs, in performing this work will examine into whether or not similar situations are occurring with respect to other defense procurements. We will furnish you with any reports that result from this work.

Sincerely yours,

/s/ Lawrence J. Powers

Acting Comptroller General
of the United States

The Honorable William Proxmire
United States Senate