

MIL-T-5091  
1 December 1949

MILITARY SPECIFICATION

TRANSMISSION, POWER, CONSTANT RATIO: GENERAL SPECIFICATION

(AIRCRAFT USE)

This specification has been approved by  
the Bureau of Aeronautics, Department of the Navy.

1. SCOPE AND CLASSIFICATION

1.1 Scope - This specification covers constant ratio power transmissions for driving aircraft accessories, remotely from aircraft engines, gear boxes or auxiliary engines.

1.2 Precedence - When the requirements of the contract, this specification, or the referenced publications and drawings conflict, the following precedence shall apply:

Contract - The contract shall have precedence over any specification or drawing.

This Specification - This specification shall have precedence over all referenced publications and drawings of Section 2 herein. Any deviation from this specification, or from the referenced publications or drawings where applicable, shall be specifically approved by the Bureau of Aeronautics.

Detail Specification and/or Drawing - The information specified in the detail specification and/or drawing, which are applicable as detail requirements of this specification, shall have precedence over any requirement of this general specification.

2. APPLICABLE SPECIFICATIONS, OTHER PUBLICATIONS AND DRAWINGS

2.1 Specifications - The following specifications and drawings of the issue in effect on date of invitation for bids shall form a part of this specification to the extent specified herein.

2.1.1 Federal Specification -

QQ-M-151 Metals, General Specification for inspection of

2.1.2 Air Force-Navy Aeronautical Specifications -

AN-QQ-A-696 Anodic films; Corrosion-Protective (for Aluminum Alloys)

AN-D-13 Drawings and Data Lists; Preparation of (For engines, Accessories and other Auxiliary Equipment)

AN-L-32 Lubrication of Aircraft; General Specification for

AN-M-12 Magnesium Alloy; Processes for Corrosion Protection of

AN-N-7 Noise, Measuring Equipment.

AN-P-61 Plating; Cadmium

AN-P-81 Packaging and Packing of Aircraft Material in Steel Shipping Containers

AN-S-126 Screw-Threads; Standard, Aircraft

2.1.3 Air Force-Navy Design Standard Drawings -

AND-10305 Generator Installation Clearance-Aircraft Engine

AND-10398 Metal, Definition of Dissimilar

2.2 Availability of Specifications and Drawings -

2.2.1 When requesting specifications and drawings, refer to both title and number. All requests for specifications and drawings should be sent to the Assistant Director of Naval Material, or Bureau of Aeronautics.

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2.2 Copies of Air Force-Navy Aeronautical, and Bureau of Aeronautics specifications and Air Force-Navy Aeronautical drawings and bulletins may be obtained upon application to the Commander, Naval Air Development Center, Johnsville, Pennsylvania, Attn: Technical Records Department.

2.2.3 Copies of Federal Specifications may be obtained upon application, accompanied by money order or coupon, or cash, to the Superintendent of Documents, Government Printing Office, Washington 25, D. C. (QQ-M-151, Price 5 cents).

### 3. REQUIREMENTS

#### 3.1 Material and Workmanship -

3.1.1 Quality of Materials - Materials used in the manufacture of transmissions shall be of high quality, suitable for the purpose, and shall conform to applicable Government specifications. Materials conforming to the contractor's specifications may be used provided the specifications are approved by the Government and contain provisions for adequate tests. The use of the contractor's specifications will not constitute waiver of Government inspection.

3.1.2 Corrosion Resistance - Materials shall be of a corrosion-resisting type or suitably processed to resist corrosion.

3.1.3 Dissimilar Metals - Unless suitably protected, dissimilar metals, as defined by AND10398, shall not be used in intimate contact with magnesium, aluminum or their alloys. When protection is used, it shall be of such type that a low impedance path is offered to radio frequency currents.

3.1.4 Standard Parts - AN standard parts and AN standard part numbers therefor shall be used wherever they are suitable for the purpose. Commercial utility parts, such as screws, bolts, nuts, washers, cotter pins, etc., may be used provided they are replaceable by AN standard parts without alteration and provided corresponding AN part numbers are referenced on the drawings and in parts lists. In applications for which no suitable corresponding AN part is in effect on date of invitation for bids, commercial parts may be used provided they conform to all requirements of this specification.

#### 3.1.5 Threaded Parts -

3.1.5.1 Screw Threads - Screw threads shall conform to the requirements of Specification AN-S-126.

3.1.5.2 Safety Wiring and Staking - Accidental loosening of screws and screw parts and other connections shall be prevented by safety wiring (.032 inch minimum OD, where practicable), staking or other approved methods. Washers and cotter pins, where used, shall be assembled in a manner which prevents rotation of washers and movement of cotter pins under conditions of vibration.

#### 3.1.6 Finish -

3.1.6.1 Aluminum Alloy Parts - Wherever practicable, aluminum alloy parts shall be anodically treated in accordance with Specification AN-QQ-A-696. The aluminum oxide film deposited by this treatment shall be removed from the actual contact area of all surfaces required to act as a path for electrical power and from the local areas under screws, nuts, or the like used for assembly or mounting purposes, to provide an adequate bonding connection.

3.1.6.2 Magnesium Alloy Parts - Wherever practicable, magnesium alloy parts shall be surface treated in accordance with Specification AN-M-12 to provide protection against corrosion.

3.1.6.3 Plating - Cadmium plating shall be in accordance with Specification AN-P-61.

3.1.6.4 Protective Coating - Any protective coating that will crack, chip or scale with age or extremes of atmospheric conditions, or that will affect the performance of the shaft, shall not be used.

3.1.6.5 Workmanship - All machined surfaces shall have a smooth finish and all details of manufacture, including the preparation of parts and accessories, shall be in accordance with the best practice for high quality equipment in this category. Particular attention shall be given to neatness and thoroughness marking parts, plating, lacquering, riveting, and ruggedness.

#### 3.2 General Design Requirements -

3.2.1 Operating Conditions - The transmission shall be designed to operate under any of the following conditions or natural combination of conditions.

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- 3.2.1.1 Pressure Altitude - Barometric pressures ranging from 30 inches of mercury down to 3.5 inches of mercury (approximating an altitude of 50,000 feet). The pressure may remain constant, or may vary at a rate as high as 0.5 inch of mercury per second.
- 3.2.1.2 Temperature - Temperature range from -55 to  $\pm 51^{\circ}\text{C}$  (-67 to  $\pm 160^{\circ}\text{F}$ ). See figure 1.
- 3.2.1.3 Humidity - Relative humidity ranging up to 100 per cent including conditions wherein condensation will take place on the equipment.
- 3.2.1.4 Sand Resistance - Under conditions of airborne sand particles.
- 3.2.1.5 Resistance to Salt Spray - Atmosphere containing salt-laden moisture.
- 3.2.1.6 Operating Position - When installed with the rotational axis in any direction.
- 3.2.1.7 Fungus - When exposed to fungus growth as encountered in tropical climate.
- 3.2.2 Simplification - Simplicity of design resulting from use of the same part for as many applications as possible in a given transmission and in transmissions of different ratings is highly desirable. For example, two ball bearing assemblies in transmissions could be identical and the same assembly used in transmissions of several configurations.
- 3.2.3 Mounting Provisions - Mounting flanges shall be in accordance with the applicable transmission drawing.
- 3.2.4 Coupling Spline - The coupling splines shall be in accordance with the applicable transmission drawing.
- 3.2.5 Torsional Vibrations - The transmission shall introduce no torsional vibrations between its input and the accessory nor shall it increase the amplitude of any torsional vibrations already existing beyond the limits herein specified.
- 3.2.6 Misalignment - The transmission shall be capable of continuous operation under full rated load both when in alignment and when a misalignment of as much as  $10^{\circ}$  exists between the axis of rotation of the input and output splines or as much as  $5^{\circ}$  between the axis of rotation of either spline and a line connecting the centers of the driving and driven mounting flanges, this latter misalignment will be referred to as "misalignment per joint". Other degrees of misalignment may be specified by the detail drawing and/or specification.
- 3.2.7 Allowance for Input Flange Displacement - The transmission shall be so constructed that the input mounting flange can move as much as two inches in any direction with respect to the output mounting flange due to motion under operating conditions. The performance of the transmission shall not suffer because of this movement.
- 3.2.8 Removable Drive Spline - The input drive spline of the transmission shall be removable in such a way that, when removed, a female spline in accordance with the applicable mating AND Standard Accessory Drive will be available. The removable spline shall be normally retained in the transmission by means of a snap ring or similar device requiring from 30 to 50 pounds to pull the spline out of the transmission.
- 3.2.9 Torque Limiting - The transmission shall be provided with a shearing section or safety disconnect in the input end which shall be easily replaceable without requiring any major disassembly or the use of special tools. Shear or decoupling shall occur within the torque values specified in the applicable drawings.
- 3.2.10 Leakage - If fluid is used for either lubrication or power transmission, the total loss of fluid shall not exceed more than 2cc per hour under any of the operating conditions covered in this specification.
- 3.2.11 Lubrication - Lubrication of the transmission shall be in accordance with Specification AN-L-32. The transmission shall not require lubrication or replenishment of lubricant during continuous operation of at least 240 hours and it is extremely desirable that the transmission require no lubrication for 1000 hours of operation. All parts of the transmission requiring lubrication as allowed above shall be provided with fittings, located so as to be readily accessible. The minimum number of fittings shall be used and, if possible, only one fitting shall be used for lubricating the entire transmission.

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3.2.12 Service Life - The transmission shall be designed so that when operating under any condition or combination of conditions described in this specification, the useful life without maintenance shall be 1000 hours or more.

3.2.13 Clearance Requirements - The clearance required by the transmission shall be as indicated on the applicable drawing.

3.2.14 Direction of Rotation - The transmission shall operate in a clockwise direction of rotation when viewed from the accessory end.

3.2.15 Intermittent Overload - The transmission shall be capable of intermittent overload operation as specified on applicable drawing. The overload shall be considered as recurring at one hour intervals.

3.2.16 Extension or Contraction Thrust - The thrust required to extend or contract the transmission, including the housing if provided, when the transmission is operated at any speed, carrying any torque up to and including continuous or intermittent overload torque and to maximum displacement from the normal position, shall not exceed 50 pounds.

3.2.17 Blast Cooling -

3.2.17.1 Blast Cooling Inlet Tube - If blast cooling is required, the transmission shall include provisions for entrance of external air through an inlet tube as specified on the applicable drawing.

3.2.17.2 Amount of Cooling - The rating of the transmission may be based on an air blast through the blast cooling inlet tube of paragraph 3.2.17.1. The pressure available will not be more than 5.31 inches water when the transmission is being provided a quantity of air equal to 130% of the basic cfm as determined from figure 2 at volumes of 130% basic cfm and less the pressure available at the transmission based on a pressure of 7" H<sub>2</sub>O static plus velocity head at the entrance of the cooling duct and pressure drops in the cooling duct determined by a pressure drop of 1.69" H<sub>2</sub>O at 130% basic cfm and 1" H<sub>2</sub>O at basic cfm.

3.2.18 Electrical Accessories - If any electrical devices are used in the construction of this device, additional requirements applicable to electrical equipment will be made effective.

3.2.19 Interchangeability - All parts having the same manufacturer's part number shall be directly and completely interchangeable with each other with respect to installation and performance. Changes in manufacturer's part numbers shall be governed by the drawing number requirements of Specification AN-D-13.

3.2.20 Marking -

3.2.20.1 Identification Marking - Parts and sub-assemblies of transmissions shall be marked with the part number and the manufacturer's name or trademark where practicable.

3.2.20.2 Nameplate - Each transmission nameplate shall be in accordance with Specification AN-P-38 and shall contain the following information:

Transmission, Constant Ratio Power (Aircraft Use)  
 NAVAER Part Number \_\_\_\_\_  
 Specification MIL-T-5091(Aer)  
 Speed Range \_\_\_\_\_  
 H.P. \_\_\_\_\_  
 Nominal Length \_\_\_\_\_  
 Lubricate every \_\_\_\_\_ hours  
 Manufacturer's Part No. \_\_\_\_\_  
 Manufacturer's Serial No. \_\_\_\_\_  
 Manufacturer's Name or Trademark (Omit Address)  
 Order or Contract No. \_\_\_\_\_

3.2.20.3 Manufacturer's Part Number on Nameplate - The manufacturer's part number indicated on this plate shall be the number of the contractor's assembly drawing which includes all sub-assembly ordering data. Any additional nameplates with proprietary data shall be attached to the transmission by means of easily removable screws.

3.2.20.4 Restriction on Size of Trademark - The manufacturer's name or trademark shall not be in letters larger than any other letters appearing on the nameplate.

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3.2.20.5 Rotation Marking - Direction of rotation shall be plainly indicated by an arrow.

3.2.21 BuAer Designations - BuAer designations shall not be used on a product until notification has been received from the Bureau of Aeronautics that the product has been approved for aeronautical use by the Bureau of Aeronautics.

3.2.22 Installation Instructions - The contractor shall pack, with each transmission, one set of instructions with illustrations and diagrams covering the installation of the transmission. Instructions shall be printed on 8-1/2 x 11 inch durable paper, and contained in an envelope.

3.2.23 Construction - The transmission may be of any type construction such as mechanical or pneumatic which meets the requirements of the specification.

3.2.24 Performance - The transmission shall satisfy the performance requirements specified in Section 4 when subjected to the tests headed as follows:

- |                         |                          |
|-------------------------|--------------------------|
| (a) Temperature         | (k) Overload             |
| (b) Thrust              | (l) Constant Ratio       |
| (c) Endurance           | (m) Acceleration         |
| (d) Normal Operation    | (n) Shock                |
| (e) Leakage             | (o) Vibration            |
| (f) Torsional Vibration | (p) Audio Noise          |
| (g) Torque Limiting     | (q) Altitude Performance |
| (h) Misalignment        | (r) Humidity             |
| (i) Overspeed           | (s) Salt spray           |
| (j) Efficiency          | (t) Sand Resistance      |
|                         | (u) Fungus               |

### 3.3 Detail Requirements -

3.3.1 Transmissions shall conform to the requirements specified on the applicable Bureau of Aeronautics detail transmission drawings and/or specifications.

## 4. METHODS OF SAMPLING, INSPECTION AND TESTS

4.1 The inspection and testing of transmissions shall be classified as follows:

- (A) Qualification Tests - Qualification tests are made on samples submitted for qualification as satisfactory products in order for the manufacturer to become eligible for listing in an appropriate Qualified Products List.
- (B) Inspection Tests - Inspection tests are made on transmissions submitted for acceptance under contract.

### 4.1.1 Qualification Tests-

4.1.1.1 Qualification tests of transmissions will be conducted by a laboratory designated by the Bureau of Aeronautics, Navy Department, Washington 25, D. C.

4.1.1.2 The qualification tests of transmissions shall consist of all the tests of this specification. The qualification tests may, at the option of the Procuring Agency, be supplemented with tests under actual service conditions to determine conformance with the requirements of this specification. The tests shall be conducted in the order listed for each transmission.

#### Transmission No. 1

Examination of Product	Temperature
Normal Operation	Altitude Performance
Overspeed	Thrust
Overload	Torsional Vibration
Acceleration	Humidity
Audio Noise	Constant Ratio
Misalignment	Efficiency
	Leakage

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## Transmission No. 2

Examination of Product	Shock
Normal Operation	Sand Resistance
Overspeed	Fungus
Overload	Salt Spray
Acceleration	Torque Limiting
Vibration	Efficiency
	Leakage

## Transmission No. 3

Examination of Product	Overload
Normal Operation (Part A)	Endurance
Overspeed	Leakage

4.1.2 Inspection Tests -

4.1.2.1 When inspection is conducted at the contractor's plant, the tests shall be accomplished by the contractor subject to the approval of the Government Inspector.

4.1.2.2 Contractors not having laboratory facilities satisfactory to the Inspector shall engage the services of a commercial testing laboratory acceptable to the Inspector.

4.1.2.3 Previous acceptance or approval of material or design by the Procuring Agency shall in no case be construed as a guarantee of the acceptance of the finished product.

4.1.2.4 The inspection tests of each transmission shall consist of the tests described in paragraphs headed as follows:

- (a) Examination of Product
- (b) Normal Operation (Part A only)
- (c) Overspeed
- (d) Overload
- (e) Leakage (during Inspection Tests)

In addition, the transmission shall be subject to any other tests specified herein which the Inspector considers necessary to determine conformance with the requirements of this specification and detail specification or drawing.

4.1.2.5 Test Records - The contractor shall maintain a record, available to the Inspector, of the results of all inspection tests required by this specification.

4.2 Examination of Product - Each transmission, sub-assembly, and part shall be examined as the Inspector may deem necessary to determine conformance with this specification and the applicable drawings with respect to materials and workmanship, standard parts, simplification, mounting provisions, coupling spline, removable drive spline, lubrication, clearance requirements, protective coating, interchangeability, marking, BuAer designations, installation instructions, dimensions and weight.

4.3 Sampling -

4.3.1 Qualification Test Samples - Qualification test samples shall consist of three transmissions and three shear sections if used in design. These transmissions shall be accompanied by two reproducible copies of outline and detail assembly drawings thereof and by two printed copies of simple instructions with illustrations and diagram, if necessary, covering the installation of the transmission. Samples shall be forwarded to a laboratory designated by the Bureau of Aeronautics, Navy Department, Washington 25, D. C., plainly identified by securely attached durable tags marked with the following information:

Constant Ratio Power Transmission (Aircraft Use)  
 BuAer Part No.  
 Specification MIL-T-5091(Aer)  
 Name of Manufacturer  
 Manufacturer's Part Number  
 "Submitted by (name) (date) for qualification test in accordance with the requirements of Specification MIL-T-5091(Aer), under authorization (reference authorizing letter)"

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4.3.2 Production Sample - Unless otherwise specified, a production sample, at the beginning of production, shall be forwarded to qualifying laboratory for test, to determine compliance with the requirements specified herein. Production samples will remain the property of the manufacturer and will be returned to the manufacturer upon completion of tests, and then, after any necessary repair, may be submitted to the local Inspector in fulfillment of the contract. The production sample shall be furnished without increasing the cost of the contract. Manufacturers will not be reimbursed for any damages occurring to the article under test. Samples shall be plainly marked "Production Sample-Order (Contract) No. \_\_\_\_\_".

4.4 Test Conditions - Unless otherwise specified, each test in this section shall be made under the following conditions:

4.4.1 Loading - The transmission shall be coupled to a suitable loading device having the  $wr^2$  indicated on the applicable transmission drawing and capable of loading the transmission over the rated load and speed range. The rotational axis of the transmission shall be horizontal and it shall be extended to its maximum length. Direction of rotation shall be clockwise facing output flange.

4.4.2 Ambient - The ambient temperature shall be  $60 \pm 10^\circ\text{C}$  ( $140 \pm 18^\circ\text{F}$ ) for all tests wherein ambient directly affects the results. For those tests in which the ambient does not directly affect the results, it may be  $25 \pm 15^\circ\text{C}$  ( $77 \pm 27^\circ\text{F}$ ).

4.4.3 Altitude - The tests shall be run at approximately sea level altitude.

4.4.4 Location of Load - The lead for the transmission shall be so arranged that it will not appreciably affect the ambient temperature of the transmission.

4.4.5 Warm-Up - Prior to each test, the transmission shall be operated at rated load at average rated speed for sufficient time to reach a substantially constant temperature.

4.4.6 Auxiliary Equipment - All additional equipment such as intercoolers, coolants, etc., indicated by the manufacturer as necessary to meet the requirements of this specification and included in the weight and dimensions of the applicable drawing shall be used.

4.4.7 Cleaning - Before testing any transmission, all corrosion preventive oil or grease or any other corrosion resistant compound shall be removed.

4.4.8 Pre-Test Operation - Prior to testing, the transmission may be operated for not more than two hours at any speed or speeds specified by the manufacturer to make certain that the mechanism is free from dirt and functioning properly before the test is started.

4.5 Test Measurements and Instructions -

4.5.1 Temperature - Input and output air and oil temperatures as applicable shall be recorded every 15 minutes, and the room temperature recorded every hour, during all operation unless otherwise indicated.

4.5.2 Speed - The transmissions speed in revolutions per minute shall be recorded every 15 minutes during all operation.

4.5.3 Leakage - Leakage shall be measured at 15 minute intervals during all testing.

4.6 Test Methods -

4.6.1 Temperature -

4.6.1.1 High Temperature - The transmission shall be subjected to an ambient temperature of  $71^\circ\text{C}$  ( $160^\circ\text{F}$ ) for at least 12 hours before operating. At the end of this period and while still at the ambient temperature, the transmission shall be operated at rated torque and rated speed for five hours. The transmission shall complete the above test without failure or impairing subsequent performance.

4.6.1.2 Low Temperature - The transmission shall be subjected to an ambient temperature of  $-55^\circ\text{C}$  ( $-67^\circ\text{F}$ ) for at least 72 hours before operating. At the end of this period and while still at the ambient temperature, the transmission shall be started and accelerated up to minimum rated speed in one minute and then run for five minutes at minimum rated speed, all at zero output torque. The transmission shall not fail nor shall its subsequent performance be impaired. The trans-

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mission will be turned by hand for two revolutions before the start of each run if so specified by the manufacturer. This test shall be repeated for a total of 25 consecutive times allowing at least five minutes between the end of each run and the start of the next run.

4.6.2 Thrust - The transmission shall be displaced horizontally either to the right or left to the limit as specified in the paragraph entitled "Misalignment" 3.2.6. The shaft shall be operated at rated torque and the thrust required to extend and contract the shaft shall be determined at minimum and maximum rated speeds. The thrust required shall not exceed 50 pounds.

4.6.3 Endurance - The transmission shall be tested for endurance carrying at least 50 percent of rated full load and for 100 hours when installed on an aircraft engine. During this test the transmission shall be run at speed in excess of the minimum speed specified on the applicable drawing. Upon completion, it shall exhibit no signs of structural weakness, wear that will interfere with the operating condition of the transmission, or indication of flaws or failure, any of which shall be cause for rejection of the transmission.

4.6.4 Normal Operation - The transmission shall satisfactorily complete the test schedule as specified in Table I. During this test schedule standard test conditions shall be maintained except that axes of rotating of input and output splines shall be misaligned by twice the "per joint" requirement specified on the applicable drawing. All measurements indicated by the test schedule shall be made and recorded where applicable.

4.6.5 Leakage - The leakage rate shall not exceed 2cc per hour during any of the tests of this specification.

4.6.6 Torsional Vibration - The transmission shall be installed on a universal joint torsional vibration machine which has a flywheel of at least 20 times the  $wr^2$  of the connected load as indicated on applicable transmission drawing. Testing procedures shall be as follows:

- (a) 100 hours with  $\pm 1$  degree torsional amplitude input to drive shaft at critical frequencies.
- (b) 50 hours with  $\pm 2$  degrees torsional amplitude input to drive.
- (c) 15 minutes with  $\pm 2$  degrees torsional amplitude input to drive shaft at critical frequencies.

During (a), (b) and (c) above, when operating the transmission below maximum rated speed indicated on the applicable drawing, the amplitude of the torsional vibration present in the output shall not exceed that applied to the input for frequencies above 15 cps; below 15 cps the output amplitude may exceed the input by as much as 100%.

4.6.7 Torque Limiting - The transmission shear section shall be tested to determine the torque required for decoupling or failure of the shearing section. The torque required shall be as specified on the applicable drawing.

4.6.8 Misalignment - During the Normal Operation test schedule of paragraph 4.6.4 there shall be no torsional vibration present in the output.

4.6.9 Overspeed - This test shall be made while the transmission is hot as a result of testing and shall be made at no load at the overspeed specified on the applicable drawing. Any governors, speed limiters, or equivalent devices shall be rendered inoperative during this test. The transmission shall demonstrate its ability to operate under overspeed conditions for five minutes without mechanical failure or impairing subsequent performance.

4.6.10 Efficiency - The efficiency shall not be less than that specified by the applicable drawing during any of the running tests of this specification within the rated load and speed range.

4.6.11 Overload - With the transmission installed in such a manner that the maximum misalignment as indicated on the applicable drawing is produced, the following test shall be made:

<u>RPM</u>	<u>Time</u>	<u>%Load</u>
Min. rated	5 min.	150%
Min. rated	5 sec.	200%
Average rated	5 min.	150%
Average rated	5 sec.	200%
Max. rated	5 min.	150%
Max. rated	5 sec.	200%

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The transmission shall demonstrate its ability to operate under the above overload conditions for the times indicated without failure or impairing subsequent performance.

4.6.12 Constant Ratio - The input and output speeds shall bear a constant ratio within 5% during all the tests of this specification including sudden removal or addition of load.

4.6.13 Acceleration -

4.6.13.1 Linear - All those portions of the transmission that might be effected by gravitational forces shall be tested by applying a sustained force equal to 10 gravitational units in both directions along each major axis of the critical part or assembly. The operation of the transmission shall not be effected in any way when these conditions are applied.

4.6.13.2 Angular - With the transmission installed in such a manner that the maximum misalignment as indicated on the applicable drawing is produced, the following test shall be made: The transmission shall be accelerated and decelerated between the limits of zero RPM 9000 RPM and back to zero RPM at the rate of 1000 RPM per second while carrying rated load. The transmission shall demonstrate its ability to complete 100 of the above cycles without failure or impairing subsequent performance.

4.6.14 Shock - The transmission shall be mounted and ten "10 G" shocks shall be applied along each of the three major axes and in both directions (60 shocks total). The transmission shall be checked for fractures etc., the presence of which shall be cause for rejection. During this test, the maximum weight and overhung moment allowed by the applicable transmission drawing shall be mounted in the output end.

4.6.15 Vibration - The transmission shall be installed so that the input end is rigidly mounted to a drive and the output end is mounted on a shake table capable of subjecting the output end of the transmission (plus the maximum weight and overhung moment allowed by the applicable drawing attached to the output pad) to simple harmonic or circular motion. The maximum deflection shall be 0.015 inches (0.03 inch maximum total excursion) up to 60 cycles per second; above 60 cycles per second the acceleration shall be limited to 5 gravitational units. A period of vibration shall consist of varying the frequency uniformly from approximately 10 to 20 cycles per second and back to 10 cps. The transmission shall be vibrated in each of three mutually perpendicular directions for 15 hours, five hours in each direction during which time the frequency of vibration shall be continuously varied in periods between 1 and 5 minutes in length. This test shall be repeated reversing the procedure namely placing the input end of the transmission on the shake table and driving through the output end. Damage or failure of any part of the transmission during this test shall be cause for rejection.

4.6.16 Audio Noise - The maximum allowable overall acoustical noise level of any part of the transmission shall be as low as practicable and when operating in the background of 90 decibels shall not increase the overall acoustical level by more than that indicated on the applicable drawing. The ratio R of the noise level for any octave to the overall noise level as specified above shall not exceed the values listed in table II. Acoustical noise level measurements shall be obtained with noise level measuring equipment in meeting the requirements of Specification AN-N-7 or equivalent.

TABLE II

Frequency Octave CPS	R
75	.98
75-150	.94
150-300	.92
300-600	.90
600-1200	.84
1200-2400	.79
2400-4800	.73

4.6.17 Altitude Performance - All those portions of the transmission that may be directly effected by altitude operations, such as cooling, lubrication and pressurization shall be tested under conditions simulating altitudes of 50,000 feet. Failure of the transmission to function properly under these conditions is cause for rejection. (Note - Figure 1 is to be considered the applicable temperature altitude reference for carrying out this test.)

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4.6.18 Humidity - The relative humidity for this test shall be  $95 \pm 5$  percent. The transmission shall be subjected to the test condition at  $71 \pm 2^\circ\text{C}$  ( $160 \pm 4^\circ\text{F}$ ) for six hours. Turn off heat source for 16 hours without changing the total moisture content in the test space. During the 16 hour period, the temperature must drop to  $38^\circ\text{C}$  ( $100^\circ\text{F}$ ) or less. Repeat a minimum of five times allowing a two-hour period to stabilize to  $71^\circ\text{C}$  ( $160^\circ\text{F}$ ). Check for corrosion, distortion and general deterioration. Immediately following this test, the transmission shall be tested in accordance with Part (A) of "Normal Operation" test schedule. Failure to pass this test is cause for rejection.

4.6.19 Salt Spray - The transmission shall be subjected to a 50-hour salt spray test in accordance with Specification QQ-M-151. Following the test, the transmission shall be washed and dried for 15 to 20 hours, then shall be tested in accordance with Part (A) of "Normal Operation test schedule. Failure to pass this test is cause for rejection.

#### 4.6.20 Sand Resistance -

4.6.20.1 Apparatus - The test apparatus shall consist of a chamber capable of maintaining uniform internal temperatures within the range of  $21$  to  $50^\circ\text{C}$  ( $70$  to  $122^\circ\text{F}$ ) and a relative humidity of not more than 10 percent. Maximum air velocities within the chamber shall not exceed  $100 \pm 10$  feet per minute. A sand dust concentration of  $1 \pm 0.1$  gram per cubic foot shall be maintained throughout the test chamber.

4.6.20.2 Test Dust - The sand and dust used in the test shall have the following characteristics:

##### (a) Particle size:

100 percent of the sand and dust shall pass through a 100 mesh screen U.S. Standard Sieve Series.

98 percent plus or minus 2 percent of the sand and dust shall pass through a 140 mesh screen U. S. Standard Sieve Series.

90 percent plus or minus 2 percent of the sand and dust shall pass through a 200 mesh screen U. S. Standard Sieve Series.

75 percent plus or minus 2 percent of the sand and dust shall pass through a 325 mesh screen U. S. Standard Sieve Series.

##### (b) Chemical Analysis:

<u>Substance</u>	<u>Percent of Total Weight</u>
SiO <sub>2</sub>	97 to 99
Fe <sub>2</sub> O <sub>3</sub>	0 to 2
Al <sub>2</sub> O <sub>3</sub>	0 to 1
TiO <sub>2</sub>	0 to 2
MgO	0 to 1
Ign losses	0 to 2

4.6.20.3 Procedure - The transmission shall be located within the test chamber in any position. The sand and dust concentration throughout the test chamber shall be maintained at  $1 \pm 0.1$  gram per cubic foot. The maximum relative humidity shall not exceed 10 percent. The ambient temperature shall not be in excess of  $50^\circ\text{C}$  ( $122^\circ\text{F}$ ) nor below  $21^\circ\text{C}$  ( $70^\circ\text{F}$ ). Sand and dust laden air velocity shall not exceed 100 feet per minute. The transmission shall be tested for a total of 8 hours. The test cycle shall be composed of 30 minute operative (no load) and 90 minute inoperative periods. The total operative end of the test, the transmission shall be thoroughly inspected. The working parts of the mechanism shall be completely free of sand and dust that might effect the operation of the transmission. Any presence of sand and dust in the working mechanism of the transmission shall be cause for rejection.

4.6.21 Fungus - The relative humidity for this test shall be 95 percent. The temperature for this test shall be  $30 \pm 3^\circ\text{C}$  ( $86 \pm 5^\circ\text{F}$ ). The transmission shall be subjected to one fungus from each of the following groups:

- (1) Group I - When cellulose is present in the test sample, Chaetomium Globosum, USDA 1042.4 or Metarrhizium glutinosum, USDA 1334.2 shall be used. When cellulose is not present in the test sample, Rhizopus nigricans, S.N. 32 or Aspergillus niger, USDA Ec 215-4247 shall be used.

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- (2) Group 2 - *Aspergillus flavus*, AML No. 15 or *Aspergillus flavus*, S.N. 3, or *Aspergillus Ustus*, J.Q.D. J272.
- (3) Group 3 - *Penicillium luteum* S.N. 41, or *Penicillium sp.*, USDA 1336.2 or *Penicillium sp.*, S.N. 40.
- (4) *Memmoniella echinata*, S.N. 2, or *Fusarium moniliforme*, USDA 1004.1, or *Trichoderma*, USDA T-1.

Substitutions for any of the above fungi may be made if specified in detail specifications. The transmission will be either dipped in or sprayed with a spore suspension before exposure to test condition. Duration of test shall be 28 days. Any evidence of destruction or deterioration on the transmission following the test shall be cause for rejection.

4.6.22 Retests - Transmissions which have been rejected may be reworked or have parts replaced to correct the defect, and resubmitted for acceptance. Before resubmitting, full particulars concerning previous rejection and the action taken to correct the defects found in the original shall be furnished the Inspector. Units rejected after retest shall not be resubmitted without the specific approval of the Procuring Agency.

## 5. PREPARATIONS FOR DELIVERY

5.1 Preservation, Packaging and Packing - The transmission shall be preserved and packaged in accordance with Specification AN-P-81.

5.2 Marking - Each container shall be marked in accordance with Navy Shipment Marking Handbook, plus packed with dehydrating agent in accordance with Specification AN-P-81 on (Date).

## 6. NOTES

6.1 The weight and dimensions of the transmission as shown on the applicable drawing shall include the weight and dimensions of all addition equipment and materials such as coolers, pipe lines, and fluid necessary to obtain performance within the requirements of this specification.

6.2 The sand and dust as outlined for use in paragraph titled "Test Dust" is commercially known as 140 mesh silica flour.

6.3 Ordering Data - Requisitions, contracts, and orders should include the Bureau of Aeronautics Drawing number.

6.4 Qualification Tests - The right is reserved to reject any bids on transmissions which have not been subjected to the required tests and found satisfactory. The attention of manufacturers is called to this provision, and they are urged to request authorization for tests of the transmissions which they propose to offer to the Navy under this specification. Requests for authorization of tests and for information as to test fees involved should be addressed to the Bureau of Aeronautics, Navy Department, Washington 25, D. C. It is to be understood that the manufacturer shall pay all transportation charges to and from the point where tests are made. In the case of failure of the sample or samples submitted, consideration will be given to the request of the manufacturer for additional tests only after it has been clearly shown that changes have been made in the product which the Government considers sufficient to warrant additional tests.

6.4.1 It is to be understood that transmissions supplied under contract shall be identical in every respect to the sample tested and found satisfactory, except for changes previously approved by the Government. Any unapproved changes from the qualification sample shall constitute cause for rejection.

6.4.2 BuAer Designations - BuAer designations shall not be used on a product, or applied to a product in correspondence or sales matter, (except qualification test samples), until notification has been received from the Bureau of Aeronautics that the product has been approved.

Patent Notice - When Government drawings, specifications, or other data are used for any purpose other than in connection with a definitely related Government procurement operation, the United States Government thereby incurs no responsibility nor any obligation whatsoever; and the fact that the Government may have formulated, furnished, or in any way supplied the said drawings, specifications, or other data is not to be regarded by implication or otherwise as in any manner licensing the holder or any person or corporation, or conveying any rights or permission to manufacture, use or sell any patented invention that may in any way be related thereto.

Part	Time (Hrs.)	RPM		% Cont. Rating	Tors. Vib.		Temperature, Degreas C				Leakage cc/Hr.	Eff. %	
		In	Out		In	Out	Oil In	Oil Out	Air In	Air Out			Ambient
A	*	6500		100%	± 0°	± 0°							
B	0 - 0.5	2000		0									
	0.5 - 1.0	2000		100									
	1.0 - 1.5	3000		0									
	1.5 - 2.0	3000		100									
	2.0 - 2.5	3500		0									
	2.5 - 3.0	3500		100									
	3.0 - 3.5	4000		0									
	3.5 - 4.0	4000		100									
	4.0 - 4.5	4500		0									
	4.5 - 5.0	4500		100									
	5.0 - 5.5	5000		0									
	5.5 - 6.0	5000		100									
	6.0 - 6.5	5500		0									
	6.5 - 7.0	5500		100									
	7.0 - 7.5	6000		0									
	7.5 - 8.0	6000		100									
	8.0 - 8.5	6500		0									
	8.5 - 9.0	6500		100									
	9.0 - 9.5	7000		0									
	9.5 - 10.0	7000		100									
	10.0 - 10.5	7500		0									
	10.5 - 11.0	7500		100									
	11.0 - 11.5	8000		0									
	11.5 - 12.0	8000		100									
	12.0 - 12.5	8500		0									
	12.5 - 13.0	8500		100									
	13.0 - 13.5	9000		0									
	13.5 - 14.0	9000		100									
	14.0 - 18.0	4000		Cycle**									
	18.0 - 22.0	6500		Cycle**									
	22.0 - 25.0	8000		Cycle**									

Notes: \* Operate until temperature rise of operating parts or coolant above the ambient does not increase more than 1°C or 2°F during a period of five minutes.  
 \*\* Load to be cycled as follows: 1 Minute at 100% Continuous Rating, 1 Minute at 50% Continuous Rating, 1 Minute at No Load and repeat.

TABLE I - NORMAL OPERATION TEST SCHEDULE

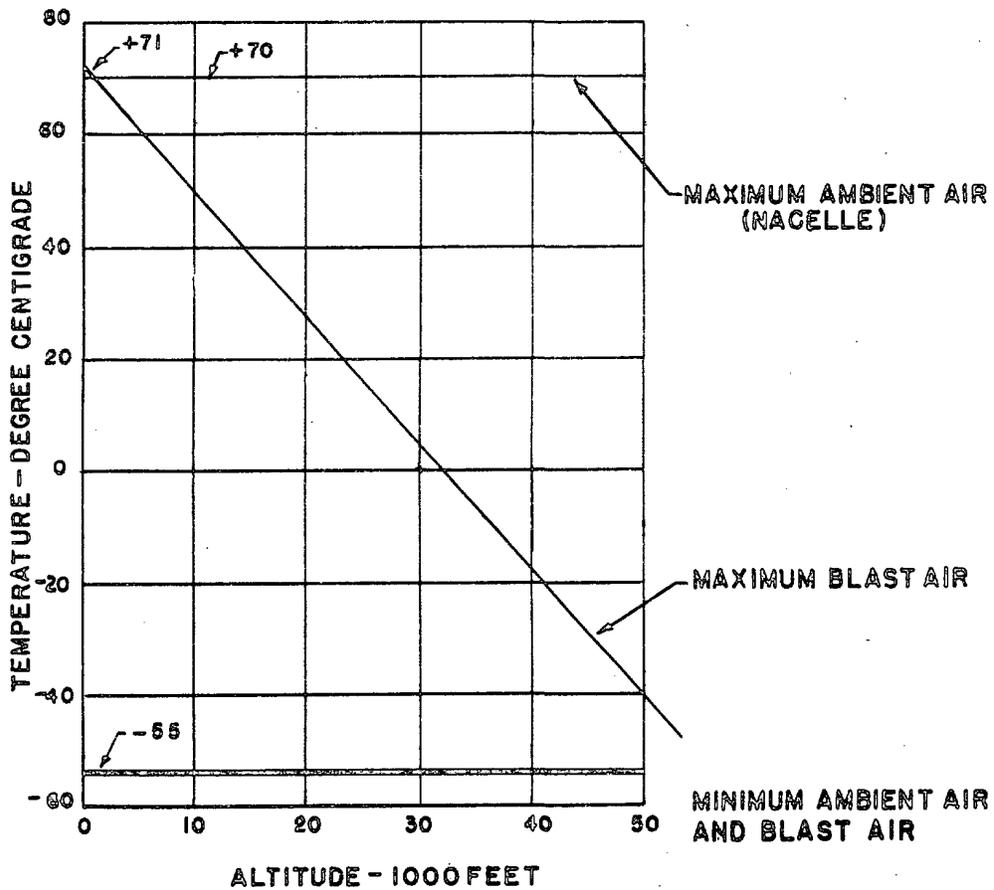


FIGURE I TEMPERATURE AND ALTITUDE RANGE OF TRANSMISSION OPERATION

SPECIFICATION ANALYSIS SHEET		Form Approved Budget Bureau No. 119-R004
<b>INSTRUCTIONS</b>		
This sheet is to be filled out by personnel either Government or contractor, involved in the use of the specification in procurement of products for ultimate use by the Department of Defense. This sheet is provided for obtaining information on the use of this specification which will insure that suitable products can be procured with a minimum amount of delay and at the least cost. Comments and the return of this form will be appreciated. Fold on lines on reverse side, staple in corner, and send to preparing activity (as indicated on reverse hereof).		
SPECIFICATION		
ORGANIZATION (of submitter)	CITY AND STATE	
CONTRACT NO.	QUANTITY OF ITEMS PROCURED	DOLLAR AMOUNT \$
MATERIAL PROCURED UNDER A		
<input type="checkbox"/> DIRECT GOVERNMENT CONTRACT <input type="checkbox"/> SUBCONTRACT		
1. HAS ANY PART OF THE SPECIFICATION CREATED PROBLEMS OR REQUIRED INTERPRETATION IN PROCUREMENT USE?		
A. GIVE PARAGRAPH NUMBER AND WORDING.		
B. RECOMMENDATIONS FOR CORRECTING THE DEFICIENCIES.		
2. COMMENTS ON ANY SPECIFICATION REQUIREMENT CONSIDERED TOO RIGID		
3. IS THE SPECIFICATION RESTRICTIVE?		
<input type="checkbox"/> YES <input type="checkbox"/> NO IF "YES", IN WHAT WAY?		
4. REMARKS (Attach any pertinent data which may be of use in improving this specification. If there are additional papers, attach to form and place both in an envelope addressed to preparing activity)		
SUBMITTED BY (Printed or typed name and activity)		DATE

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