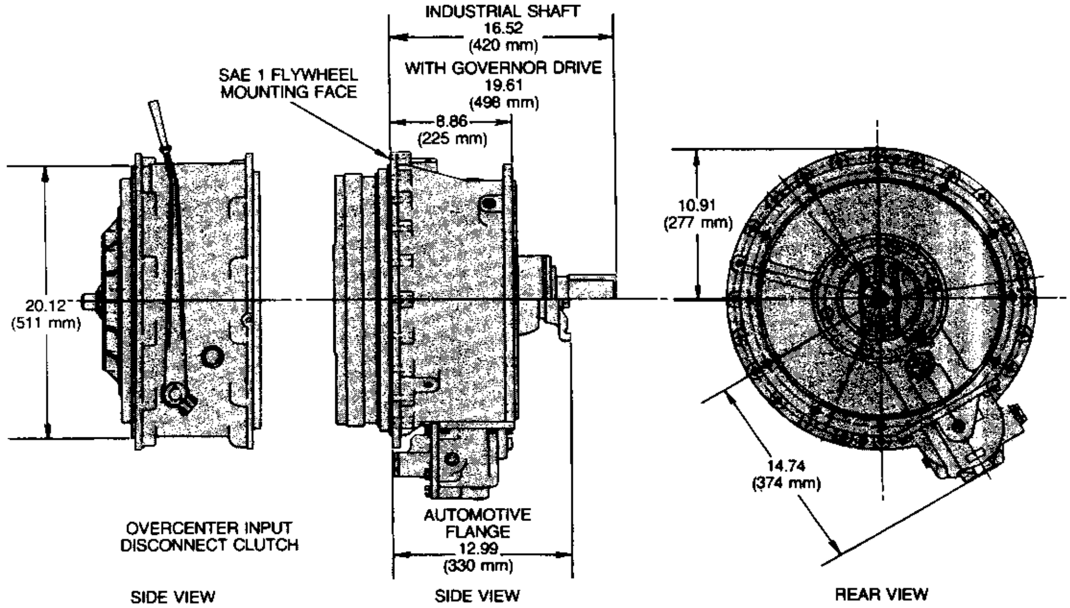
TC 500 SERIES

The TC 500 series industrial torque converters are used in a variety of applications including shovels, cranes, draglines, backhoes, motor graders, winches and hoists, drilling rigs, snowplows, oil field equipment, rock crushers, ski tows and rail switchers.

MOUNTING DIMENSIONS



Note: Dimensions are given in inches with metric values in parentheses.

WITH

4 DESIGN FEATURES IN 1

- One standard housing for all engines in the horsepower range
- Wider engine horsepower coverage
- Greater parts interchangeability for a variety of installations
- Greater versatility of installation for any given engine

OPTIONS

- Industrial shaft output or automotive flanges
- Manual overcenter input disconnect clutch
- Over-running clutch
- Accessory drive
- Choice of torque converter ratios
- Hydraulic lockup clutch

SPECIFICATIONS

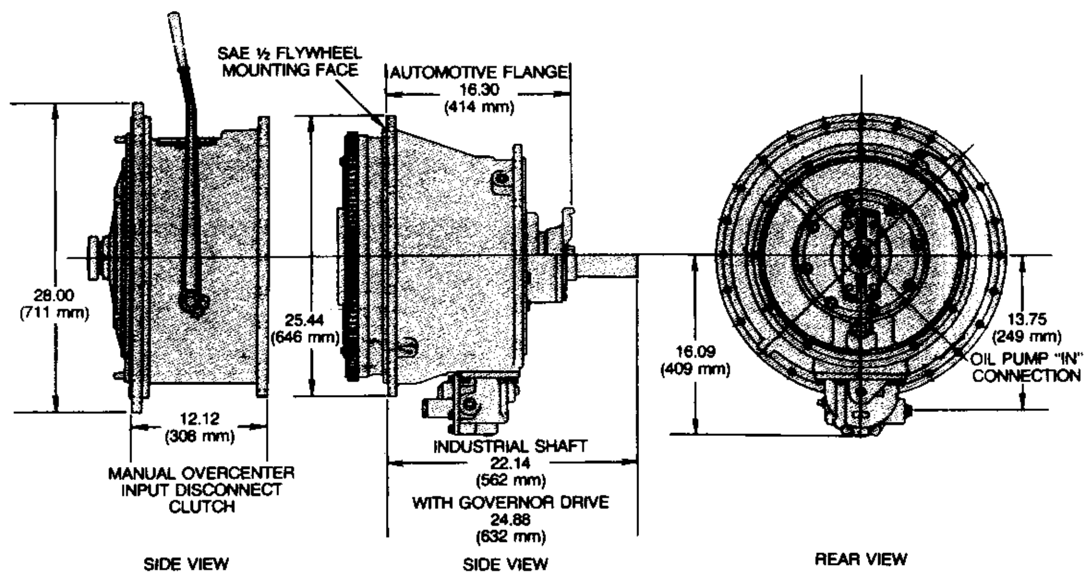
Model	TC 530	TC 540	TC 550	TC 560	TC 570	TC 580
Stall torque ratio	3.48:1	2.64:1	3.29:1	2.58:1	3.06:1	2.81:1

Input power (max) net	412 HP (307 kW)
Input torque (max) net	865 lb ft (1173 N·m)
Input speed (max)	2500 rpm
Oil type	Hydraulic transmission fluid type C-3
Converter oil capacity	Remote sump 10 US gal (37.9 Liters) min
Type	1-stage; 2-phase; 3-element
Output shaft	Automotive or industrial
Flywheel housing	SAE 1
Weight	603 lbs approx max (273 kg)

TC 800-900 SERIES

The TC 800 and TC 900 series industrial torque converters are used in a variety of applications including backhoes, winches, and hoists, drilling rigs, oil field equipment, pump drives, rail equipment and rock crushers.

MOUNTING DIMENSIONS



Note: Dimensions are given in inches with metric values in parenthesis.

FEATURES

multiplies torque hydraulically

applies power to the load smoothly and finally

permits use of lower horsepower engines

protects against shock load damage to engine and equipment

prevents harmful engine lugging and stalling

increases life of engine and equipment

adjusts variation between engines in multiple installation

OPTIONS

Accessory drive

40 gpm charging pump

Manual input disconnect clutch

Industrial shaft output or automotive flanges

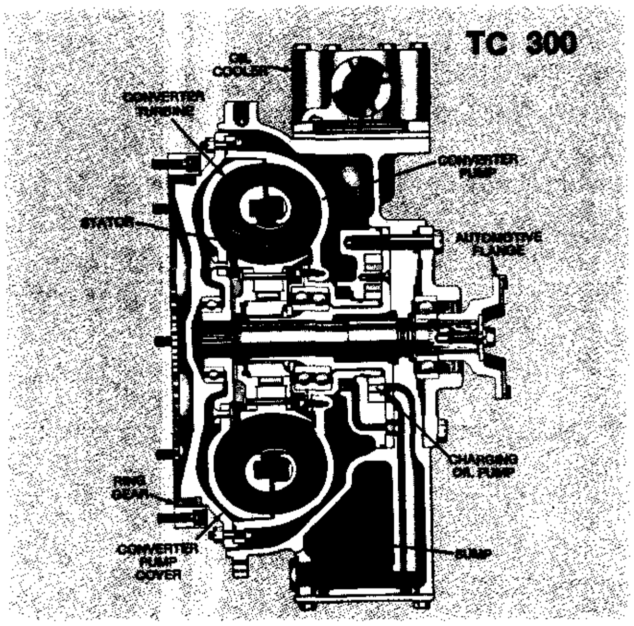
SPECIFICATIONS

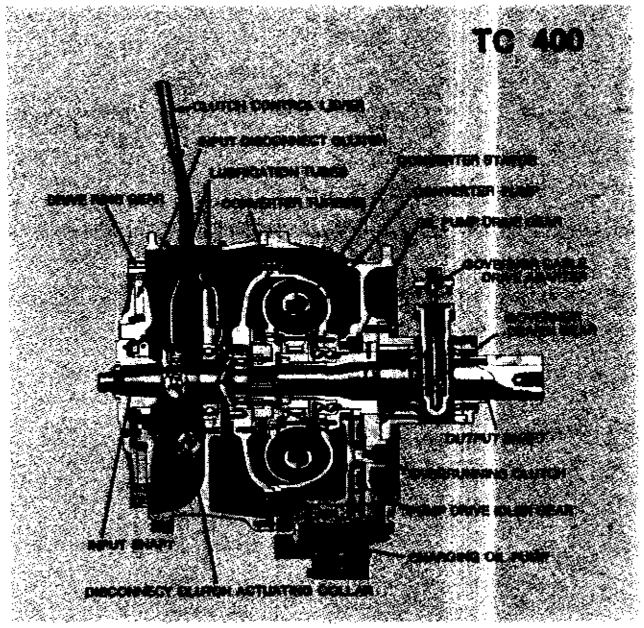
Model	TC 840	TC 860	TC 940	TC 960
Stall torque ratio	2.92:1	3.98:1	2.71:1	3.67:1

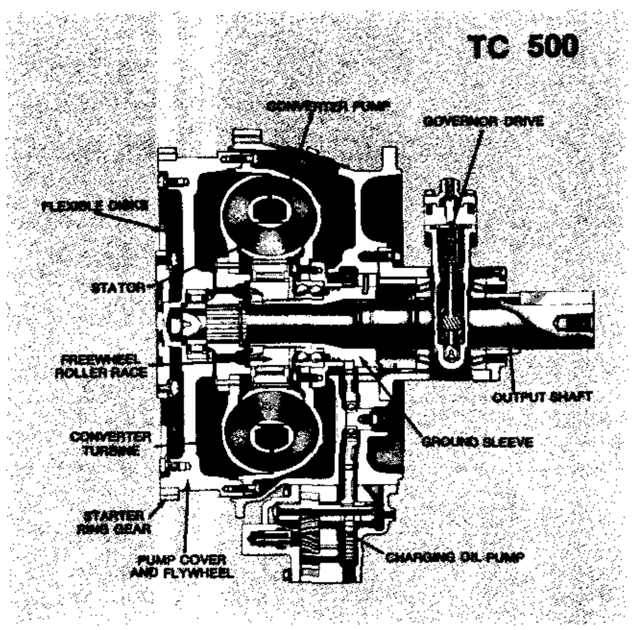
Input power (max) net	426 HP (318 kW) *586 HP (438 kW)
Input torque (max) net	1470 lb ft (1993 N·m) *1065 lb ft (1444 N·m)
Input speed (max)	2100 rpm
Oil type	Hydraulic transmission fluid type C-3
Converter oil capacity	Remote sump 10 US gal (37.9 Liters) min
Type	1-stage; 3-phase; 4-element
Output shaft	Automotive or industrial
Flywheel housing	SAE ½ (SAE 0 to ½ adapter available)
Weight	950 lbs approx max (431 kg)

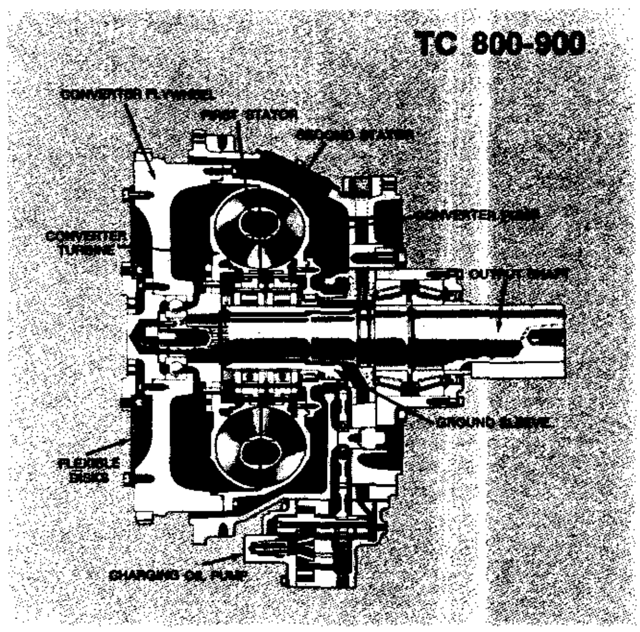
*with optional charging oil pump on TC 900 series only

Allison Industrial Torque Converters









Detroit Diesel Allison
Division of General Motors Corporation
P.O. Box 894, Indianapolis, Indiana 46206
(317/244-1511)

WORLDWIDE REGIONAL OFFICES

Atlanta, Georgia (404/252-3314)
Oak Brook, Illinois (312/654-6600)
Dallas, Texas (214/659-5050)
Dearborn, Michigan (313/565-0411)
Edison, New Jersey (201/246-5074)
Fremont, California (415/498-5200)
Westlake Village, California (213/997-5405)
London, Ontario, Canada (519/452-5000)
Rotterdam, The Netherlands (010-290-000)
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Jakarta, Indonesia
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Santiago, Chile
Sao Paulo, Brazil

SA 1352 10/81

Litho in U.S.A.

III APPLICATION & INSTALLATION
(A & I)

Formal Application and Installation (A&I) takes into account three considerations: 1) basic engine/transmission combination; 2) application — which takes into account entire drivetrain specifications, operating conditions and terrain, and customer performance requirements; and 3) a review of the physical layout and vehicle performance after the transmission has been installed.

A&I's are offered as a customer service to ensure optimum performance of the Allison Transmission. Following are detailed instructions on how to complete an A&I, along with sample forms for both on and off highway applications. Form SA1545, Distributor Sales Review, is provided as a guide for distributors when considering regears or one-time application/installations.

Instructions for ordering additional A&I forms are included in the literature section of this book.

OFF HIGHWAY APPLICATION & INSTALLATION REVIEW

APPLICATION REVIEW TRANSMISSION MODEL ______ DATE ______

GENERAL INFORMATION

(1) MFGR.'S NAME ______
MFGR.'S ADDRESS ______
MFGR.'S REP. NAME ______ CO. POSITION ______
DDA REGION ______ REGION REPRESENTATIVE ______
ANTICIPATED VOLUME ______ PROTOTYPE PLAN – YES ______ NO ______ QTY & DATE ______
GOVERNMENTAL OR OTHER SPECS TO BE MET ______

EQUIPMENT DESCRIPTION

(2) MODEL & TYPE ______
VEHICLE CAPACITY ______
(3) VEH. WT. (GVW/GCW): EACH AXLE ______ kg, ______ kg, ______ kg, TOTAL ______ kg
EMPTY VEHICLE WT.: EACH AXLE ______ kg, ______ kg, ______ kg, TOTAL ______ kg
TOTAL NO. OF AXLES ______ NO. OF DRIVING AXLES ______
AUXILIARY TRANSMISSIONS OR TRANSFER CASES:
AHEAD OF TRANSMISSIONS: MODEL ______ RATIO ______
BEHIND TRANSMISSION: MODEL ______ RATIO ______
DIFFERENTIAL & FINAL REDUCTION RATIO ______
TIRE SIZE ______ LOADED RADIUS ______ mm SPROCKET PITCH DIAM. ______ mm
REQUIRED OPERATING SPEED: MAX. ______ km/h MIN. ______ km/h
MAX. OPERATING SLOPE: FORE & AFT ______ PERCENT, SIDE ______ PERCENT
(4) DESCRIPTION OF INTENDED DUTY ______

ENGINE SPECIFICATIONS

(5)

MAKE & MODEL	GROSS kW	NET kW*	FULL LOAD GOVERNOR SPEED	ENGINE CURVE NO. & DATE

ENGINE RATING AT ______ °C AND ______ m ALTITUDE
*ENGINE ACCESSORIES ONLY (FAN, ALTERNATOR, COMPRESSOR)

PTO SPECIFICATIONS

(6)

MODEL	LOCATION	FLOW LITRES/SEC GOV. SPEED	RELIEF PRESS kPa	IDLE kW	MAX. INT. DUTY kW	NORMAL DUTY kW

TRANSMISSION SPECIFICATIONS

(7) MODEL ______ CONVERTER ______ ENG/CONV. MATCH ______
TRANS. GEAR RATIOS ______ ______ ______ ______ ______ TRANSFER GEAR RATIO ______
(8) COMMENTS ON APPLICATION ______

TRANSMISSION APPLICATION REVIEWED BY:

(9) APPLICATION ENGINEER: ______ DATE ______
(10) CHIEF ENGINEER: ______ DATE ______
(11) MANAGER-SALES: ______ DATE ______

SA0004A (Front) (4/79)

INSTALLATION REVIEW

TRANSMISSION CONFIGURATION

⑫ REMOTE MOUNT ______ ENGINE MOUNT ______ ADAPT. DRAWING ______

OPTIONS:

RETARDER	____	PARK BRAKE	____	CLUTCH C.O.	____
PTO (ENGINE)	____	REMOTE FILTER	____	INCH CONTROL	____
PTO (TURBINE)	____	SPEEDO DRIVE	____	TORQMATIC COUPLING	____
MANUAL HYD.	____	MANUAL ELEC.	____	AUTOMATIC ELEC.	____

OTHER ______

INSTALLATION DATA

DRIVELINES — INPUT DAMPER TYPE ______ RATE ______

INPUT DRIVELINE: VENDOR ______ SIZE ______ LENGTH ______ mm
ANGLE: VERTICAL ______ °HORIZONTAL ______ °
FLANGE PARALLELISM: DEGREES ______ °

OUTPUT DRIVELINE: (REAR) VENDOR ______ SIZE ______ LENGTH ______ mm
ANGLE: VERTICAL ______ °HORIZONTAL ______ °
FLANGE PARALLELISM: DEGREES ______ °

OUTPUT DRIVELINE: (FRONT) VENDOR ______ SIZE ______ LENGTH ______ mm
ANGLE: VERTICAL ______ °HORIZONTAL ______ °
FLANGE PARALLELISM: DEGREES ______ °

TRANSMISSION SUPPORTS:

TRUNNION TYPE: ______
ANGLE BRACKET: ______
ISOLATORS: YES ______ NO ______ TYPE ______
TRANSMISSION INSTALLATION ANGLE ______ °

CONTROL LINKAGE:

SHIFT CONTROL : (TYPE & MAKE) ______
RETARDER CONTROL: (TYPE & MAKE) ______
CLUTCH CUT-OFF: (TYPE & MAKE) ______
INCHING CONTROL: (TYPE & MAKE) ______
VEHICLE ELECTRICAL SYSTEM: VOLTAGE ______ GROUND (+ or −) ______

TRANSMISSION HEAT EXCHANGER:

MAKE ______ MODEL ______

SUPPORT DATA

GENERAL VEHICLE ARRANGEMENT — POWER TRAIN — LAYOUT NO. ______
MOUNTING LAYOUT NO. ______
DRIVELINE LAYOUT NO. ______
CONTROL LAYOUT NO. ______
COOLING CIRCUIT DIAGRAM & PERFORMANCE DATA NO. ______
TORSIONAL DRIVE TRAIN ANALYSIS NO. ______
FILTER CIRCUIT DIAGRAM NO. ______
OIL LEVEL CHECKING ARRANGEMENT NO. ______

⑬ INSTALLATION CHECKED BY: ______ DATE ______

⑭ COMMENTS ON INSTALLATION: ______

INSTALLATION REVIEWED BY:

CHIEF ENGINEER   MANAGER SALES

⑮ APPLICATION ENGINEER: ______ DATE ______
ASSISTANT CHIEF ENGINEER: ______ DATE ______

SA 0004A (Back) (4/79)

THE OFF-HIGHWAY APPLICATION AND INSTALLATION REVIEW FORM (SA 0004A)

This describes the basic objectives of the A & I Review Form, defines how to complete it and outlines the sequence of events which lead to a complete A & I and defines areas of responsibilities.

I. Purpose of the A & I Form

The purpose of the Application and Installation Review form, SA 0004A, is to ensure the following:

A. The transmission selected will provide the described performance and durability to result in a satisfactory application.

B. The transmission has been installed in accordance with established practice, and has been checked out to minimize problems in production and in the field.

C. A basis for evaluating new applications based upon past experience has been provided.

D. The completed form on file in DDA Applications Engineering, Sales and the OEM aids in quickly retrieving the salient data to aid in resolving field problems if and when they occur.

Actually, the A & I form serves two purposes. The front, Application Review, is filled out at the earliest possible time, if possible, during initial contact. Review of this information ensures that the appropriate transmission has been selected and that DDA Engineering concurs with the application. DDA Engineering has adopted a policy of processing properly prepared Application Reviews within thirty days of receipt. Difficult reviews which require more than routine effort may require up to 60 days.

Once the Application Review is complete and the application accepted, the installation engineering effort can be initiated by the OEM.

The reverse side of the form, Installation Review, is to be completed after the actual physical installation checkout. The OEM is formally advised that the installation has been reviewed, a prototype checked out and the installation accepted, any exceptions are noted by DDA Engineering.

II. Completing and Submitting the Application Review Form

The Application Review on the front side of the A & I form is completed by the Zone Sales Manager in conjunction with the OEM. The completed Application Review with SCAAN summaries is forwarded to Indianapolis Sales. Sales will check the submitted Review to verify its completion and type on the proper form. Sales then submits the Application Review to Engineering with an M-request and a metric SCAAN summary for every vehicle configuration covered in the review.

To aid in completing the form and to provide the background on why the data is required, the following comments are keyed to the Arabic numerals on the attached form, Figures 1a and 1b.

1. **General Information**

   Complete all the general information section since this will establish a contact and a source of information at the OEM in the event the regional Sales contact cannot be reached. This section also defines the scope, timing and potential of the program. ANTICIPATED ANNUAL VOLUME is very important, but is often neglected.

2. **Model and Type**

   Enter the model designation, i.e. RD6000, C7, etc. The vehicle type or vocation should be also included here. Typical vehicle vocations are shown in Figure 2. Selection of the proper vehicle vocation is important since it will determine the following points:

   A) which transmissions are available and their appropriate ratings

   B) driveline and other drivetrain component efficiencies

   C) other vehicle performance parameters such as rolling resistance and air resistance coefficients

   D) acceptable vehicle guidelines for transmission approval (Example: vehicle gradeability, Reference SCAAN Application Data, PUB 35 for guideline and information

   When the vehicle does not satisfy the requirements of the vocation guidelines or when the vehicle is in a vocation which is not listed, then an explanation should be included in the DESCRIPTION OF INTENDED DUTY, Item 4.

3. **Vehicle Data**

   Vehicle data is required to calculate performance to insure that the vehicle will meet the off-highway guidelines and standards, as well as any special requirements. (Note: All data is to be in metric units. A list of conversion factors follows on page 6.) When multiple speed axles or auxiliaries are used, show all ratios. When optional axle or tire size is available and approval is desired, the options should be included. For tracklaying vehicles, replace the rolling *radius* with sprocket pitch *diameter*.

4. **Description of Duty and Special Performance Requirements**

   In some cases duty-cycle data will play an important part in the review of analysis. Particularly, in cases where a vehicle does not meet SCAAN guidelines and/or the duty is not typical (i.e. Are special grade requirements necessary? Is the vehicle required to negotiate steep grades?)

Include special requirements or information not covered by this form, such as unusual altitudes or ambient temperatures, etc. When government specifications must be met, include those requirements.

5. **Engine Specifications**

   A net engine curve is highly desirable. It not available, provide a gross curve or reference a standard engine manufacturer's curve. Standard vocation losses will be assumed unless specified. Include all engines for which approval is desired.

   Note that the net power which is entered in the "net kW" column includes only fan, alternator and compressor losses. Additional losses should be entered in the PTO Specifications, item 6.

6. **PTO Specifications**

   All transmission-driven power take-offs should be listed. Include make and model and location on transmission. It is important to know the power requirements for each PTO at idle, normal and maximum load. If power is not known, then flow (liters per second) and relief pressure (kilopascals) should be provided so that power may be calculated.

   The net power entered in item 5, plus all the PTO idle power losses, should be equivalent to the net horsepower indicated on the SCAAN performance run.

7. **Transmission Specifications**

   Fill in transmission model and torque converter. If special converter, planetary, or output ratios are required, fill these in (especially important for the cycling transmission series). Note: whether the transmission is remote or directly mounted to the engine and whether the output is straight through or includes an integral dropbox. Be sure to include the approximate SCAAN performance number(s). A SCAAN must be run for *every* engine, tire and axle combination.

Application Review Steps

In completing the Application Review, the Application Engineer will perform the following major tasks:

- Check engine against transmission rating and verify converter selection based upon a review of SCAAN comparisons of:
  input speed
  input torque and horsepower
  turbine torque
  match criteria
- Determine whether the engine has been analyzed for torsional compatibility with the transmission. If a torsional analysis is not available in the Tech Data Library or if the transmission is remotely mounted, then a torsional study will be initiated. The input data required for this study is outlined in the installation manuals (Section 1.5). Please provide with submittal of the A & I for all remote applications.
- Determine appropriate shift calibration to optimize performance and economy and minimize noise.
- Check vehicle data to assure all guidelines are met.
- Check vehicle against current experience (review existing A & I's).
- Check vehicle to ensure special performance requirements are met (gradeability, acceleration).

New applications:

- Review duty cycle
- Run life studies if necessary for applications beyond our experience.

8. *Comments on Applications.* The DDA Application Engineer will note if the application is considered *acceptable* or *not acceptable.* Comments regarding the applications will be made as required. Any limitations will be noted, i.e. vehicle will be road-load limited to a 56 mph at rated weight although geared for 62 mph, etc.
9. The Application Engineer reviewing the application will sign the document and make a recommendation to Engineering management.
10. After the formal review, the Director of Transmission Engineering will sign the form on the line marked CHIEF ENGINEER.
11. The Manager of Sales will sign and the completed form will be forwarded to the OEM.

During the interim between the Application Review and the installation checkout and upon receipt of the data drawings the Application Engineer will:

- Check driveline to ensure compliance to guidelines
- Run duty cycle analysis (if required)
- Check installation layouts against the design checklist

A letter of suggested changes will then be forwarded to the OEM, if required.

III. **Installation Review**

The Installation Review on the back side of the form is filled out at the time of the vehicle checkout.

The Support Data should have been reviewed prior to the vehicle installation checkout, if available; if not, then at the time of the checkout.

12. The Application Engineer or his designated representative will complete the installation checkout using the application checkout work sheet and then will complete the installation review form. A copy of the installation checkout sheet is provided in Section 5.3 of the Installation Manual.
13. Comments on the installation will be noted. Any exceptions will be listed, i.e. the installation is acceptable with the exception of the driveline angles which exceed the establish limits of good driveline practices by 30°.
14. The review form will be signed by the individual performing the checkout (either the Application Engineer or his designated representative).
15. The Application Engineer will sign the form after a review of the completed form and work sheet and make a recommendation to the Chief Engineer, Application Engineering. The Chief Engineer will sign the form on the line marked ASST. CHIEF ENGR., after a formal review.

In the event that an item is critical and exceeds established practice, the form will be directed to the Director of Transmission Engineering for his initials.

The form will be forwarded to Sales for initialing and then transmitted to the OEM.

CONVERSION FACTORS

CHASSIS

Wheelbase: ______ in. × 25.4 = ______ mm (millimeters)

Top Geared Speed ______ mph × 1.609 = ______ km/h (Kilometers/hour)

Frontal Area ______ ft² × .093 = ______ m (meters squared)

Rolling Radius ______ in. × 25.4 = ______ mm (Millimeters)

Weight/GVW/GCW ______ lbs. × .454 = ______ kg (Kilograms)

ENGINE SPECIFICATIONS

Net/Gross Horsepower ______ × .745 = ______ kW (Kilowatts)

Engine Rating

Sea Level (0)

500 ft = 152.4 meter

60°F = 15.6°C

85°F = 29.4°C

VEHICLE VOCATION DESCRIPTION

OFF-HIGHWAY HAULING

- Pan Scraper—Scraper with single front engine and without elevator. Consult Application Engineering if twin-powered pan scraper performance is required.
- Elevating Scraper—Scraper with single front engine and elevator mechanism. Performance is often required with and without elevator mechanism.
- Rear Dump—Off-highway rear dump truck typically found in mining operations.
- 4-WHL DR Prime Mover/Tow Tractor—Off-highway tractor for towing heavy loads such as ore or salt.
- Underground Mine Haul—Vehicle for underground mining operations. Performance requirements determined by individual applications.
- Bottom Dump—Off-highway hauler which dumps load through bottom of vehicle. Normally, a tractor trailer configuration.

Figure 2A

OFF-HIGHWAY CYCLING

- Wheel Loader—4×4 articulated vehicle with a hydraulic front bucket used for stockpiling, excavating, mining, etc.
- Loader, Backhoe—Tractor with rear mounted backhoe. Front Loader bucket is generally used only to fill in ditch. 4×4 or 4×2 nonarticulated.
- Fork Lift, Hard Surface—Tractor with front fork lift. 4×2 nonarticulated. Normally equal speeds forward and reverse. Ballast weights may be required.
- Fork Lift, Rough Terrain—4×4 articulated vehicle with front fork lift mechanism.
- Log Handler—Vehicle similar to a rough terrain fork lift except that it uses grapples or other log handling device.
- Skidder—Articulated 4×4 vehicle used for skidding logs.
- Compactor, Sanitary Landfill—4×4 articulated loader chassis fitted with special wheels for compacting refuse.
- Compactor, Soil Compaction—Specialty 4×4 articulated vehicle using sheep's foot or similar compaction device.
- Roller, Drum/Rubber Tire—Vehicle used for final soil or other surface compaction.
- Wheeled Dozer—4×4 vehicle with dozer blade.
- Tracked Dozer—Crawler tractor with dozer blade.
- Mobile Crane, Rough Terrain—Vehicle which carries a hydraulic crane. Same power train operates crane as propels vehicle. Also called a hydraulic articulated crane.

Figure 2A

SPECIALIZED EQUIPMENT

- Oil Field Pumping Unit—Pumping equipment requiring manual-automatic controls. May or may not be mounted on a vehicle. Since this vocation is a power train, only transmission performance is available.
- Hoist/Winch—Examples are the lift mechanism on a crane carrier or an anchor winch on an off-shore driling platform. Since vocation is a power train, only transmission performance is available.
- Auger—Power train for an earth drill which itself may be mounted on a variety of vehicles. Since its vocation is a power train, only transmission performance is available.
- Locomotive Rail Equipment—Freight yard switching, rail repair equipment, or powered passenger rail car.
- Agricultural Tractor—Farm vehicle used to pull and/or operate mounted trailing implements.
- Agricultural Spreader/Sprayer—Farm vehicle used to broadcast dry chemicals or spray liquid chemicals.
- Agricultural Hauler—Farm vehicle used for hauling produce trailers.
- Military, Wheeled—Any wheeled military vehicle not built to commercial standards. High-mobility trucks, APC's, etc.
- Military, Tracked—All tracked military vehicles.
- Industrial Converter—Torque converter only, often used in oil-field drilling equipment.

ON-/OFF-HIGHWAY

- Tractor Trailer, On/Off-Highway—General purpose tractor trailer typified by a log hauler.
- Heavy Equipment Transport—4×6 or 6×6 tractor used to pull a low boy trailer and its equipment.
- Crane Carrier—Vehicle which transports a large crane having its own power train. Use mobile crane vocation (5600) for cranes which are powered by the vehicle power train.
- Oil Field Servicing Rig—Straight truck which transports oil field equipment, notably a mobile drilling rig. Use (61009) vocation for drilling and pumping rig performance.
- Straddle Carrier—Vehicle which straddles load, lifts and carries it forward or reverse with equal ease.
- Crash Truck—Airport fire fighting vehicle usually requiring pump and roll capability. This vocation requires conformance with government specifications.

Figure 2B

Allison Transmissions

DISTRIBUTOR SALES REVIEW (SA-1545)

This form is provided as a guide for the proper sale of DDA Transmission Products. For a complete Application and Installation Review use Form SA 0003A or SA 0004A.

ON HIGHWAY________ OFF HIGHWAY________

EQUIPMENT

MODEL & TYPE ______________________________

VEH. WT. (GVW/GCW) __________lbs. TOTAL WT. ON DRIVE AXLE(S) ______________________ lbs.

AUXILIARY TRANSMISSIONS ______________________ RATIOS ______________________

VEH. SPEED AT ENGINE GOV. RPM __________ MPH MAX. OPERATING SLOPE ______________________

DESCRIPTION OF INTENDED DUTY ______________________________

EXTREME OPERATING CONDITIONS, IF ANY ______________________________

TRANSMISSION

MODEL ______________ CONV. ______________ ASSEMBLY NO. ______________

PTO: LOCATION ______________________ NORMAL DUTY HP ______________

______________________ ______________

MOUNTING: REMOTE __________ ENGINE __________ RETARDER: YES __________ NO __________

ENGINE

MAKE & MODEL ______________ NET HP______________ FULL LOAD GOV. RPM ______________

______________ ______________ ______________

GENERAL

CUSTOMER ______________________________

DISTRIBUTOR ______________________ REPRESENTATIVE ______________ DATE________

ANTICIPATED VOLUME ______________________________

COMMENTS ______________________________

____

MGR. DISTRIBUTOR & FLEET SALES ______________________ DATE ________

Form No. SA-1545 Revised 5/77

HIGHWAY APPLICATION & INSTALLATION REVIEW

APPLICATION REVIEW TRANSMISSION MODEL ____________ DATE ______

GENERAL INFORMATION

MFGR. NAME: ____________
MFGR. ADDRESS: ____________
① MFGR. REP. NAME: ____________ CO. POSITION: ____________
DDA REGION: ____________ REGION REPRESENTATIVE: ____________
ANTICIPATED VOLUME: ____________ PROTOTYPE PLAN — YES ______ NO ______ QTY. & DATE ______

VEHICLE DESCRIPTION

② MODEL & TYPE: ____________
③ TYPE OF SERVICE: ☐ ON-HIGHWAY ☐ ON/OFF-HIGHWAY
④ APPLICATION:

CONSTRUCTION	SPECIAL SERVICE	PICKUP & DELIVERY	OVER-THE-ROAD
☐ DUMP	☐ OIL EXPLORATION	☐ REFUSE PACKER	☐ SHORT HAUL
☐ TRANSIT MIX	☐ TRAILER SPOTTER	☐ BUS	☐ EQUIPMENT HAULER
☐ BLOCK TRUCK	☐ UTILITY	☐ LIQUID DELIVERY	☐ LOGGER
	☐ REFUELER	☐ VAN BODY	☐ LINE HAUL
	☐ MOTOR HOME	☐ FARM	
	☐ FIRE TRUCK		

⑤ ☐ OTHER: ____________

CHASSIS:

WHEELBASE: ____________ mm NO. OF AXLES: ______ NO. DRIVE AXLES: ______ FRONTAL AREA: ______ m^2
WEIGHT DRIVE AXLES ______ kg TOP GEARED SPEED ______, ______ km/h
⑥ AUXILIARY TRANSMISSION/TRANSFER CASE MODEL ______ RATIO(S) ______,
______, ______, ______, AXLE RATIO(S) ______, ______,
______ TIRE SIZE: ______, ______, ______, ROLLING RADIUS ______, ______ mm
RATED GVW/GCW: ______ kg, CURB: ______ kg

⑦ DESCRIPTION OF INTENDED DUTY: ____________

ENGINE SPECIFICATIONS

⑧

MAKE & MODEL	GROSS kW	NET kW	FULL LOAD GOV. RPM	CURVE NO. & DATE

ENGINE RATING AT ______ °C AND ______ m ALTITUDE

TRANSMISSION SPECIFICATIONS

⑨ MODEL: ______ CONVERTER: ______ PERFORMANCE CURVE: ______
⑩ COMMENTS ON APPLICATION: ____________

TRANSMISSION APPLICATION REVIEWED BY:
⑪ APPLICATION ENGINEER: ______ DATE ______
⑫ CHIEF ENGINEER: ______ DATE ______
⑬ MANAGER-SALES: ______ DATE ______

FORM SA 0003A (Front) (4/79)

Figure 1 (Front)

TRANSMISSION CONFIGURATION

A/N ______ ADAPTATION DRAWING ______
PTO TURBINE: ______ PTO ENGINE: ______ RETARDER: ______

INSTALLATION DATA

MOUNTING & TYPE: ______

REAR ENGINE MOUNTS

OFF. ENG. ______ OFF TRANS. ______ REAR SUPPORT: ______

DRIVELINE

TYPE & SIZE: ______ TUBE O.D. ______ WALL THICKNESS ______

ANGLES

TRANSMISSION: ______ AUXILIARY: ______ FORWARD, REAR AXLE: ______

DRIVELINES #1: ______ #2: ______ #3: ______

JOINT INDEX ______

SHAFT LENGTH — JOINT #1: ______ #2: ______ #3: ______

CONTROLS

SHIFT CONTROL (TYPE & MAKE) ______

MODULATOR CONTROL (TYPE & MAKE) ______

RETARDER CONTROL (TYPE & MAKE) ______

COOLING

TRANSMISSION HEAT EXCHANGER (MAKE & MODEL): ______ PERFORMANCE CURVE: ______

RADIATOR MAKE: ______ SIZE: ______ cm² ______

PTO (TYPE & MAKE) ______

INSTRUMENTATION

TRANS. TEMP. ______

TACHOMETER: ______

SPEEDOMETER DRIVEN GEAR ______

OIL FILL TYPE & DIP STICK (MAKE & MODEL) ______

⑭

SUPPORT DATA

GENERAL ARRANGEMENT LAYOUT NO. ______

PHYSICAL ADAPTATION LAYOUT NO. ______

MOUNTING LAYOUT NO. ______

DRIVELINE LAYOUT NO. ______

CONTROLS AND LINKAGE LAYOUT NO. ______

COOLING CIRCUIT LAYOUT NO. ______

OIL FILLTUBE & DIPSTICK LAYOUT NO. ______

⑮ INSTALLATION CHECKED BY: ______ DATE ______

⑯ COMMENTS ON INSTALLATION ______

______

______

INSTALLATION REVIEWED BY:

⑱ CHIEF ENGINEER ⑲ MANAGER SALES ⑰ APPLICATION ENGINEER ______ DATE ______

ASST. CHIEF ENGINEER ______ DATE ______

Figure 1 (Back)

FORM SA 0003A (Back) (4/79)

THE HIGHWAY APPLICATION AND INSTALLATION REVIEW FORM (SA 0003A)

This describes the basic objectives of the A&I Review Form, defines how to complete it and outlines the sequence of events which lead to a complete A&I and defines areas of responsibilities.

I. **Purpose of the A&I Form**

The purpose of the Application and Installation Review Form, SA 0003A, is to ensure the following:

A. The transmission selected will provide the desired performance and durability to result in a satisfactory application.

B. The transmission has been installed in accordance with established practice, and has been checked out to minimize problems in production and in the field.

C. A basis for evaluating new applications based upon past experience has been provided.

D. The completed form on file in DDA Applications Engineering, Sales and the OEM aids in quickly retrieving the salient data to aid in resolving field problems if and when they occur.

Actually, the A&I is a form that serves two purposes. The front side of the form, Application Review, is filled out at the earliest possible time, during initial contact if possible. This ensures that the appropriate transmission has been selected and that DDA Engineering concurs with the application. DDA Engineering has adapted a policy of processing Application Reviews within thirty days of receipt. Difficult reviews which require more than routine effort may require up to 60 days. Once the Application Review is completed and the application accepted, the installation engineering effort can be initiated by the OEM. The reverse side of the form, Installation Review, is to be completed after the actual physical installation checkout. The OEM is formally advised that the installation has been reveiwed, a prototype checked out and the installation accepted, any exceptions are noted by DDA Engineering.

II. **Completing the Application Review Form**

The Application Review on the front side of the form is to be completed by the Detroit Diesel Allison Zone Sales Manager with the OEM. To aid in completing the form and to provide the background on why the data is required, the following comments are offered. Please note that the comments are keyed to the Arabic numerals on the attached form, Figure 1.

1. **General Information**

   Complete all the general information section since this will establish a contact and a source of information at the OEM in the event the DDA Regional Sales contact cannot be reached. This section also defines the scope, timing and potential of the program.

2. **Model and Type**

   Enter the OEM truck model, i.e. C900 and type - Conventional, Cabover-Engine (COE), etc.

3. **Enter Type of Service**

   On-Highway Vehicles—operate on primary and secondary maintained road surfaces, graded dirt, gravel or paved.

   On/Off-Highway Vehicles—will operate on virgin terrain during part of their duty cycle. Typical on/off-highway applications are dumps, transit mix, and some refuse trucks.

4. Applications have been categorized where possible to aid in comparing past experience to the new application being reviewed.

   These categories which are not self-explanatory or, where additional data would be helpful, are described in general terms below:

Construction

Block Truck: Hauls concrete building block and material to construction site (On-Off-highway application).

Special Service

Oil Exploration: Specialty trucks for geophysical survey, etc. Generally includes more ratio coverage than required to meet on/off-highway ratio guidelines in order to provide greater speed control. Vehicles operate in remote areas.

Trailer Spotter: Extremely rugged, short wheelbase tractor geared for low top speed to dhuttle trailers in a truck terminal or railroad depot or "piggy back" operation.

Utility Truck: Used by an electric utility for powerline construction and maintenance in metropolitan and remote areas. The vehicle generally incorporates special equipment, i.e., augers, booms, etc. which are driven by the transmission PTO.

Pick-Up and Delivery

Refuse Packer: Garbage-trash pickups can generally be categorized into one of the three following groups:

- Commercial or industrial pickup hauling to satellite collection point (On-Highway application).
- Commercial or industrial pickup hauling to a landfill (On-Highway application but provide approximately 25% startability).
- Haul trucks (Roll-off or semitrailer) to carry refuse from the satellite collection point to the landfill (On-Off-Highway).

Bus: Specify if a school bus, tour bus, feeder line or transit bus. In providing vehicle data, provide curb weight, and for gross vehicle weight include rated weight GVWR and design weight, if different, i.e. 24,000 lbs. rated—20,000 lbs. design full seated passenger load (no standees) and 50% standees, etc.

Liquid Delivery: Either a straight truck or tractor hauling bulk fuel, chemicals, etc.

Farm: Universal farm vehicle, generally a stake bed. Used for hauling harvest from the field to market, hauling cattle and general hauling.

Over-the-Road

Short Haul: Sometimes referred to as a city tractor. Used normally for hauling finished goods, raw materials in and around urban or metropolitan areas. These vehicles will have less power and are generally single axle applications.

Equipment Hauler: Used to haul construction equipment or heavy industrial equipment, i.e., transformers, etc.

Line Haul: Long haul tractor/trailers typically run from 60 to 80,000 lbs. GCW, although weights up to 130,000 lbs. are not uncommon. The vehicles are generally tandem axle rigs of higher horsepower (270-430 HP) than a city tractor to maintain vehicle speed.

5. **Other**

   If the vehicle does not fall within one of the standard categories, provide as much detail as possible.

6. This vehicle data is required to perform the performance calculations to insure that the vehicle will meet the on-highway and on/off-highway guidelines and standards, as well as any special requirements. (Note: All data is to be in metric units. A list of conversion factors is attached in Figure 2.) If two-speed axles are used, show both ratios:/. If other axles are available and approval is desired, please include those ratios.

7. **Description of Duty**

   In many cases, duty-cycle data will play an important part in the review analysis, particularly in cases where a vehicle does not meet conventional guidelines and/or the duty is not typical. If special grade requirements are necessary, i.e. is the vehicle required to negotiate steep secondary grades or dock ramps? Include special requirements or information not covered by this form, such as unusual ambient temperatures, etc. If government specifications must be met, please include those requirements.

8. **Engine Specifications**

   A net engine curve is highly desirable. If not available, provide a gross curve or reference a standard engine manufacturer's curve. Standard automotive losses will be assumed unless specified. (Note: for buses include air conditioning losses since they represent a more significant parasitic loss.) Include all engines for which approval is desired.

9. Fill in transmission model, converter and performance curve number, if known. If not, DDA Engineering will complete.

   Application Review Steps

   In completing the Application Review, the Application Engineer will perform the following major tasks:

   - Check engine against transmission rating and select converter based upon a review of:

     Input speed
     Input torque and horsepower
     Turbine torque

   - Check vehicle data:

On/Off-Highway	Does it meet tractive effort requirements? Will it meet top speed requirements?
On-Highway	Will it meet top speed requirements? Will it meet startability requirements?
Transit Coach	Does it meet transit coach rating requirements? Does it meet Government performance specifications?

Check against current experience (review of existing A&I's).

Check to ensure special performance requirements are met (gradeability, acceleration).

• If a new application:

Review duty cycle

Run life studies, if necessary, for applications beyond our experience.

10. **Comments on Applications**

The DDA Application Engineer will note if the application is considered **acceptable** or **not acceptable.** Comments regarding the applications will be made as required. Any limitations will be noted, i.e., vehicle will be road-load limited to a 56 mph at rated weight although geared for 62 mph, etc.

11. The Application Engineer reviewing the application will sign the document and make a recommendation to Engineering management.

12. The Director of Transmission Engineering will sign the form after the formal review.

The form will be returned to Sales via IOM for Sales signature. This IOM will also request the following additional information as required:

Installation layouts
Detail duty cycle data

13. The Manager of Sales will sign and the completed form will be forwarded to the OEM.

During the interim time between the Application Review and the installation checkout and upon receipt of the data/drawings, the Application Engineer will:

Check driveline to ensure compliance to guidelines

Run duty cycle analysis (if required)

Check installation layouts against the design check list

A letter of suggested changes will then be forwarded to the OEM if required.

III. **Installation Review**

The Installation Review on the back side of the form is filled out at the time of the vehicle checkout.

14. The Support Data should have been reviewed prior to the vehicle installation checkout, if available; if not, then at the time of the checkout.

The Application Engineer or his designated representative will complete the installation checkout using the application checkout work sheet and then will complete the installation review form.

15. The review form will be signed by the individual performing the checkout (either the Application Engineer or his designated representative).

16. Comments on the installation will be noted. Any exceptions will be listed, i.e., the installation is acceptable with the exception of the driveline angles which exceed the established limits of good driveline practices by 3°.

17. The Application Engineer will sign the form after a review of the completed form and work sheet and make a recommendation to the Chief Engineer, Application Engineering. The Chief Engineer will sign after a formal review.

18. In the event that an item is critical and exceeds established practice, the form will be directed to the Director of Transmission Engineering for his initials.

19. The form will be forwarded to Sales for initialing and then transmitted to the OEM.

CONVERSION FACTORS

CHASSIS

Wheelbase ____________ In. × 25.4 = ____________ mm (millimeters)

Top Geared Speed ____________ mph × 1.609 = ____________ kmph (kilometers per hr.)

Frontal Area ____________ ft^2 × .093 = ____________ m^2 (meters squared)

Rolling Radius ____________ In. × 25.4 = ____________ mm (millimeters)

Weight/GVW/GCW ____________ Lbs. × .454 = ____________ kg (kilograms)

ENGINE SPECIFICATIONS

Net/Gross Horsepower ____________ × .745 = ____________ kW (kilowatts)

Engine Rating

Sea Level (0)

500 ft. = 152.4 meters

60°F = 15.6°C

85°F = 29.4°C

Figure 2

IV INSTALLATION MANUALS

CYCLING
OFF-HIGHWAY TRANSMISSIONS
INSTALLATION MANUAL

Transmissions Engineering

Detroit Diesel Allison
Division of General Motors Corporation

Indianapolis, Indiana 46206

CYCLING TRANSMISSIONS INSTALLATION MANUAL

INTRODUCTION

This manual has been written to facilitate the proper installation of the following off-highway cycling transmissions:

CYCLING SERIES:

T(R)T 2000	T(R)T 3000	T(R) T4000	CRT 5000
MODELS:			
TT 2000-1	TT 3000-1	TT 4721-1	CRT 5633 LOADER
TRT 2000-1	TRT 3000-1	TRT 4821-1	CRT 5633 NONLOADER
TRT 2000-3			CRT 5633-7 w/o DROPBOX
TRT 2010-3			CRT 5643-2
TTB 2000-1			

Some subjects covered within this manual encompass all cycling transmission series. However, other topics because of their complex nature and/or the options available have been divided into sections according to models to provide clarity. A MAJOR TOPICS Table of Contents at the beginning of this manual outlines the sections and subsections. An introduction, subtopics Table of Contents, and Lists of Figures and Tables at the beginning of each section indicate the corresponding subjects pertinent to all Allison Cycling Transmissions and material applicable depending on the particular model.

Data in this manual is to be used in conjunction with the appropriate installation drawings which are referenced throughout each section. Because of the continuously changing variety of standard support components available, a separate document called SUPPORT EQUIPMENT FOR CYCLING TRANSMISSIONS is published to aid engineers and designers in the selection of the most appropriate transmission supplementary components.

Revisions to update this manual will be distributed as additional installation experience is accumulated and design improvements are developed and released. New material will be identified, by the manual code CIM-section-page number, and date of revision at the bottom of each page, for easy insertion into the manual. A cover letter will provide instructions for adding, deleting, and replacing the pages.

Please contact your local Detroit Diesel Allison distributor or Detroit Diesel Allison GM, Transmission Applications Engineering, K5, P. O. Box 894, Indianapolis, IN 46206, when additional information is needed for application or installation of Allison cycling transmissions.

MAJOR TOPICS

Table of Contents

CYCLING TRANSMISSIONS INSTALLATION MANUAL

1. TRANSMISSION-VEHICLE INTERFACE

Introduction

The interface requirements are essential to the installation of the transmission in a vehicle. The transmission input, output, and mounting designs must be coordinated with the vehicle and component designs in order to ensure reliable transfer of power. Specifications for these transmission designs are provided in this section.

This section of the installation manual includes methods to determine the extent of engine torsionals and driveline disturbances. The guidelines to limit these effects on the transmission in order to prevent unsatisfactory transmission reliability due to an incompatible vehicle system design are also included.

MODEL SERIES: T(R)T 2000, T(R)T 3000, T(R)T 4000, and CRT 5000

Subtopics apply to all Allison cycling transmissions unless otherwise noted.

Table of Contents

1. TRANSMISSION-VEHICLE INTERFACE

List of Figures and Tables

1.1 ENGINE ADAPTATION

The Allison cycling transmissions have provisions for direct engine-mounted installations or remote-mounted installations. Since the input and output driveline configuration is the principle vehicle interface requirement for remote-mounted units, Section 1.3 FLANGE PROVISIONS and Section 1.4 DRIVELINES, should be consulted for these applications. The major concern of a direct-engine mounted installation is the adaptation. The adaptation involves coupling the physical parts of the transmission input to the engine flywheel and crankshaft by following certain installation requirements.

The drive coupling of the adaptation transmits power from the engine crankshaft to the converter or transmission. This connection must be capable of transmitting maximum engine torque without creating excessive thrust on the engine crankshaft. The drive coupling must provide a pilot for the converter that will maintain acceptable concentricity between the engine and the transmission. The general type of drive coupling used on cycling transmissions is a flexdrive. The flexdrive coupling has proven the most desirable method of transmitting engine power to the converter or transmission. This very durable arrangement is virtually noiseless and transmits minimum thrust to the engine crankshaft. However, a drive ring coupling is available for the TT 2000 Series Transmissions.

1.1.1 SAE Standard Engine Adaptation

The twin turbine transmissions and the CRT 5643-2 have standard SAE flexdrive adaptations which are recognized throughout the industry. Flywheels, flywheel spacers, and/or adapter housings will be provided by engine manufacturers. The standard flexdrive engine adaptation may be described as follows:

- The converter front cover is piloted in the flywheel or flywheel adapter.
- A flexdrive assembly and retainer plate are piloted on and bolted to the converter front cover.
- The outer-diameter bolt circle on the flexdrive assembly is bolted to the flywheel or flywheel spacer.
- A flywheel-housing adapter is used when required to provide proper axial spacing.
- The flywheel and starter ring gear are supplied and located by the engine manufacturer.
- As the converter is mounted to the engine, the converter front cover pilot enters the engine flywheel and the flexplates are bolted to the flywheel through an access hole provided in the flywheel housing.

The flexplate design in Twin Turbine transmissions incorporates the lamination concept. The design consists of four or five flexplates of .79 mm (.031 in.) or 0.56 mm (.022 in.) thickness depending upon model. Flexplate material is SAE 1008-1022 cold-rolled steel with a Rockwell B70-B90 hardness. A rust-inhibiting protective coating is applied. Flexdrive assemblies with or without welded nuts are used depending upon the location of the flywheel housing access opening.

A satisfactory engine and converter adaptation conforms to the dimensional requirements shown on the following installation drawings:

Transmission Series	Installation Drawing
T(R)T 2000, T(R)T 3000	AS 00-016
T(R)T 4000	AS 42-009
CRT 5643-2	AS 56-025

In addition, DDA recommends design practices for engine-mounted transmission adaptations. These adaptations and practices are described in the Sections noted below:

- Engine Flywheel Housing, Section 1.1.3
- TT2000 Drive-ring Coupling, Section 1.1.4
- Cap Screw Selection, Section 1.1.5
- Starter Requirements, Section 1.1.6

1.1.2 Crankshaft-piloted Flexdrive

A typical CRT5633 crankshaft-piloted flexdrive is illustrated in Figure 1.1-1. This type drive may be described as follows:

- Crankshaft adapter is piloted on and fastened to the engine crankshaft. This adapter has an outside diameter pilot for the flexplates and an inside-diameter pilot for the flywheel.
- A flexdrive assembly, of three, four, or five flexplates and a wear plate, is piloted on and bolted to the crankshaft adapter.
- The starter ring gear is installed on the converter flywheel in accordance with the engine manufacturer's recommendations.
- To mount the converter to the engine, the converter flywheel pilots into the crankshaft adapter. The flexdrive is bolted to the converter flywheel at the outer-diameter bolt circle.

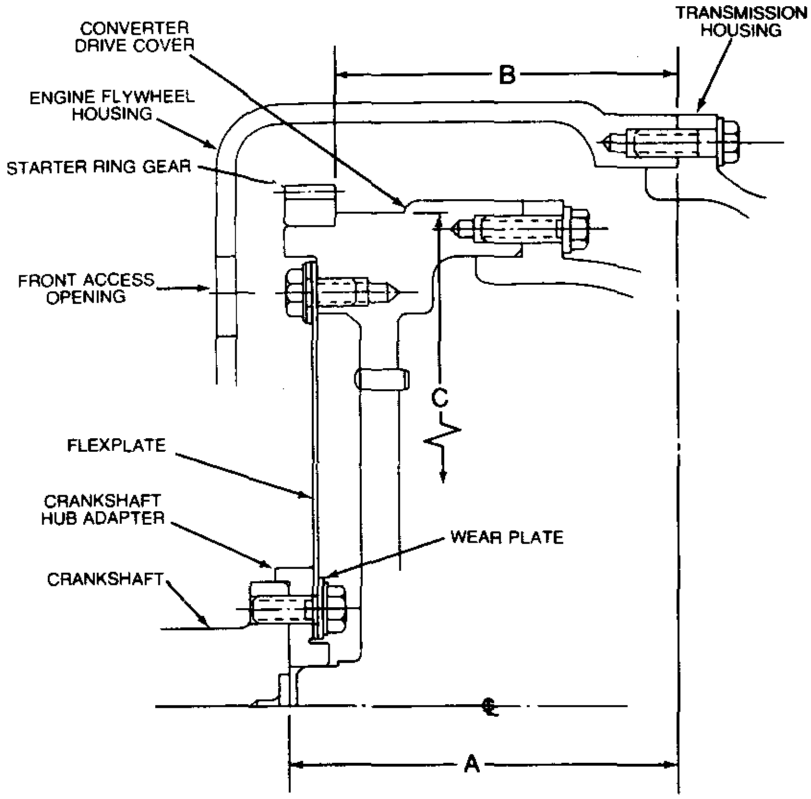


Figure 1.1-1 CRT 5633 crankshaft-piloted flexdrive

1.1.2.1 **Existing Design Adaptations.** To determine the adaptation requirements for existing engine and Allison cycling transmission combinations, refer to AS 04-XXX Installation Drawings. Series AS 04-XXX drawings furnish the following pertinent information for direct engine-mount installations:

- flywheel assembly part number
- starter ring gear part number (In many cases the ring gear is a detail of the flywheel assembly.)
- crankshaft hub part number
- flexdrive assembly part number for drive connection between the crankshaft hub and the flywheel assembly with attaching hardware
- part numbers of adapter plates and housing, if used
- parts that must be ordered separately
- cross-section illustration of the physical assembly with pertinent dimensions.

When a particular transmission-engine combination is not listed in the Sales Department AS 04 Adaptation Drawing Listing, contact Detroit Diesel Allison, Transmission Applications Engineering, to determine if the adaptation has been designed since publication of the index. When the required physical adaptation does not exist for the CRT 5633, refer to AS 00-001 Drawing to initiate the adaptation design.

1.1.2.2 **Adaptation Design Proposal Contents.** If current CRT 5633 adaptations are not applicable then the equipment builder or his engine manufacturer must forward drawings and information about a proposed adaptation to DDA Transmission Engineering in order to obtain approval for installation. The details of a design proposal should include:

1) A detail print of the proposed adapter design which defines the location of the flexdrive as specified for the CRT5633 transmission; the bolt circle of the crankshaft adapter; the crankshaft-pilot diameter and its tolerance.

2) A reproducible print of the starter ring gear that specifies the recommended press fit and assembly instructions especially when the gear is not symmetrical.

3) Adaptation layout drawings that detail:

a) the crankshaft to transmission housing dimension 'A', and its total tolerance including allowable crankshaft end play,

b) the starter ring gear to transmission housing dimension 'B', for optimum engagement, with maximum and minimum allowable tolerances to avoid interference with the pinion or starter motor operation,

c) the maximum flywheel diameter 'C', for adequate clearance between the engine flywheel housing and attaching parts,

d) engine flywheel housing details,

e) bolts, washers, and other parts extending into the flywheel housing cavity, and

f) the flywheel flexplate, if not supplied by DDA.

These drawings and dimensions will indicate the clearance between the transmission flywheel, the engine flywheel housing and the attaching parts; and will define the adaptation to ensure proper assembly.

1.1.2.3 **Adaptation Design Considerations.** In order to obtain a satisfactory engine-to-transmission adaptation, several design considerations for each of the major components in an adaptation should be observed:

Flywheel Housing. For the CRT 5633, provisions for a wet-type flywheel housing must be made. Refer to Installation Drawing AS 56-015 or AS 56-016 for details. Splitline gaskets, sealed starter, double seal on the crankshaft, and drain-back provision must be supplied on the engine. In addition, a 38 mm (1.50 in.) minimum diameter access hole must be provided in the housing for installing the flexdrive-to-flywheel bolts at assembly.

Crankshaft Adapter. The adapter should be designed to provide adequate piloting and proper thickness to allow a minimum axial flexdrive deflection. To insure proper adaptation, closely control adapter pilot diameters and axial dimensions. The adapter should provide a pilot with a minimum length of 2.54 mm (.100 in.) for engagement of the converter flywheel. Provisions for adequate thread engagement and use of material with sufficient strength to transmit full engine torque is equally important. A typical crankshaft adapter is shown in Figure 1.1-2 which illustrates tolerances and specifications as a guide for design and fabrication.

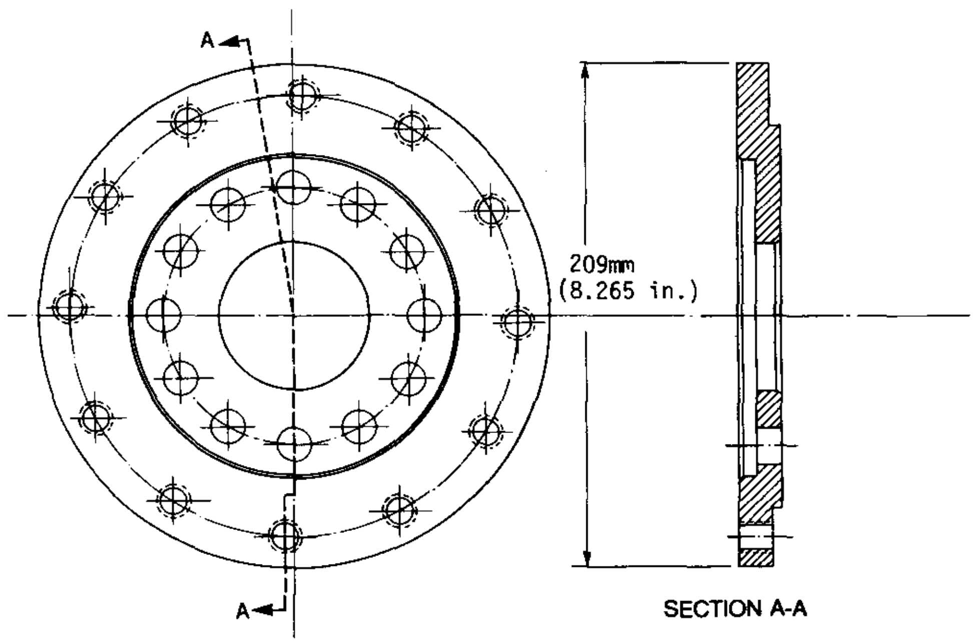


Figure 1.1-2 Crankshaft adapter, Part No. 6882609

Coupling Flexplate. The CRT 5633 flexdrive design utilizes the lamination concept. Five flexplates are used in each assembly; each flexplate is 0.71-0.86 mm (.028 to .034 in.) thick. The flexplates are generally made from cold-rolled steel with a rust and fingerprint inhibitor coating. Refer to Table 1.1-1, Flexplate specifications, for design of engine and converter adaptation for the CRT 5633 transmission.

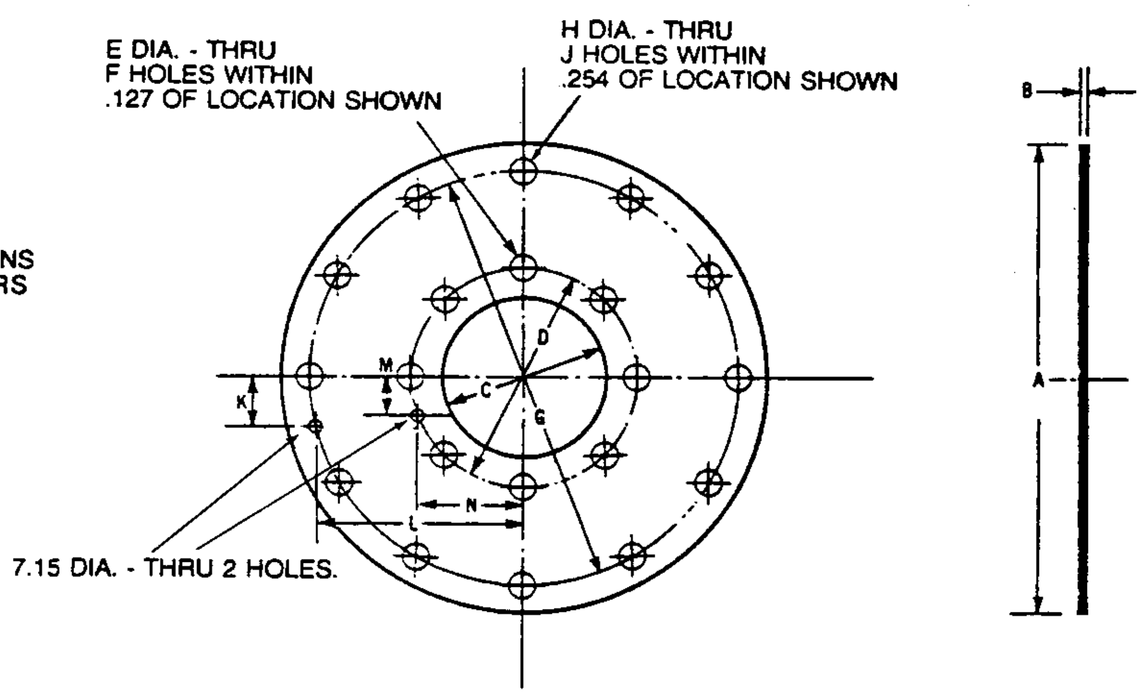
SAE Grade 8 **self-locking bolts are** recommended to attach the flexdrive to the adapter hub. Use hard steel wear plate under the self-locking bolts to prevent mutilation of the flexdrive and to provide uniform clamping at the interior dimension (I.D.) of the flexdrive. The DDA **wear plate** for the CRT5633 is available with the following dimensions:

- Bolt Circle: 12 holes of 14.2 mm (.56 in.) diameter on bolt circle diameter of 184 mm (7.25 in.).
- Diameter: 160 mm (6.312 in.) inside diameter; 210 mm (8.250 in.) outside diameter.
- Thickness: 3.05 mm (.120 in.).

Table 1.1-1 Flexplate specifications

Transmission Model:						
	TT 2000	TT 3000	TT 4000	TT 4000	CRT 5643	CRT 5633
Flexplate Part No.:						
	6774007	6777448	6881587	6880941	6880941	6768381
Dimensions in Millimeters:						
A	350.80	350.80	389.89	431.80	431.80	431.80
B	0.559	0.559	0.559	0.787	0.787	0.787
C	85.80	85.80	85.80	85.80	85.80	165.20
D	111.76	111.76	119.38	119.38	119.38	190.50
E	13.49	13.49	13.49	13.49	13.49	13.49
F	6	6	6	12	12	12
G	333.38	333.38	371.48	406.40	406.40	406.40
H	11.91	11.91	11.91	11.91	11.91	14.30
J	8	8	12	12	12	12
K	-	63.78	48.06	26.52	26.52	30.18
L	-	154.00	179.40	201.47	201.47	200.94

ALL DIMENSIONS
IN MILLIMETERS

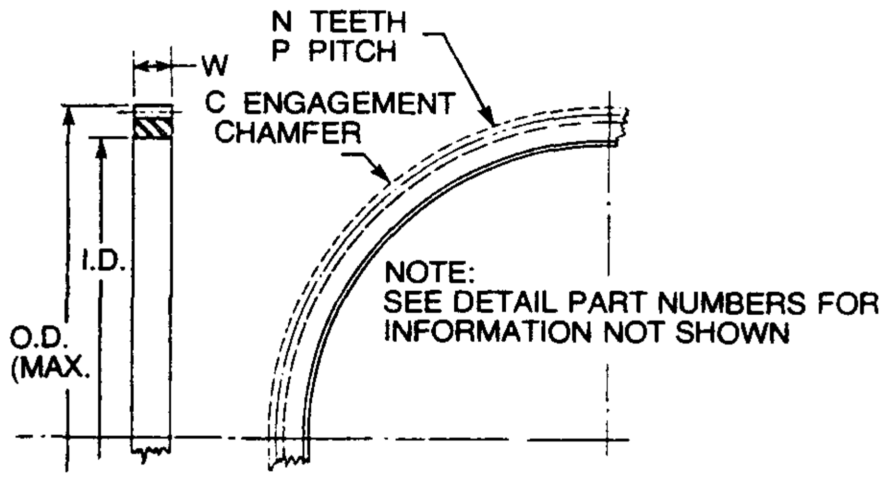


Engine Starter Ring Gear. The ring gear is installed by DDA on the flywheel. However, the engine manufacturer specifies the type and location. Refer to Table 1.1-2 Starter ring gear specifications for gear designs of current adaptations.

Table 1.1-2 Starter ring gear specifications

Adapt to Engine Flywheel Housing SAE No.	Engine Mfg.	C*	I.D.	O.D.	W	N	P	Ring Gear Part No.
			Dimensions In Inches					
1	A-C	U	18.178	20.057	1.00	119	6-8	6754106
1	A-C	U	18.178	20.057	1.00	199	6-8	6754106
1	Caterpillar	B	18.123	19.786	.94	117	6-8	6773504
1	Caterpillar	B	18.130	19.580	1.00	116	6-8	6770028
1	Continental	B	18.500	19.930	.88	158	8-10	6768359
1	Cummins	B	17.839	19.387	.87	115	6-8	6769433
1	Cummins	B	18.500	19.887	.99	118	6-8	6752502
1	Cummins	D	18.372	19.887	.99	ll8	6-8	6751948
1	DDA	B	18.458	19.917	1.00	118	6-8	5166664
1	DDA	U	18.458	19.917	1.00	118	6-8	5184773
1	Hall-Scott	B	18.378	19.700	.75	156	8-10	6759466
1	Le Roi	B	17.998	19.950	.94	158	8-10	6757504
1	Mack	B	18.242	19.905	.86	118	6-8	6769131
1	Waukesha	B	18.500	19.930	.88	158	8-10	6753594
2	A-C	B	15.940	17.225	.69	102	6-8	6772919
2	Caterpillar	B	15.998	18.795	.94	117	6-8	6772767
2	Continental	None	16.164	17.533	.86	104	6-8	6759883
2	Cummins	B	15.996	17.386	.87	103	6-8	6771283
2	DDA	U	15.857	17.251	1.00	102	6-8	5188030
2	DDA	None	16.355	16.894	.54	138	8-10	5116302
2	Hall-Scott	B	16.190	17.450	.75	138	8-10	6772660
2	Hercules	B	15.938	17.055	.88	135	8-10	6770825

* B: Bendix; D: Dyer; U: Universal.



Converter Flywheel. The flywheel may be spot-faced to provide adequate clearance for the bolt heads, when insufficient clearance causing interference between the crankshaft bolts and the converter flywheel is found during the adaptation study. In this case, two pins may be used to insure proper indexing of the adapter hub to the crankshaft bolts and the converter-flywheel spot faces during assembly.

In addition to these design considerations, DDA recommends design practices for engine-mounted transmission adaptations which are described in the following sections:

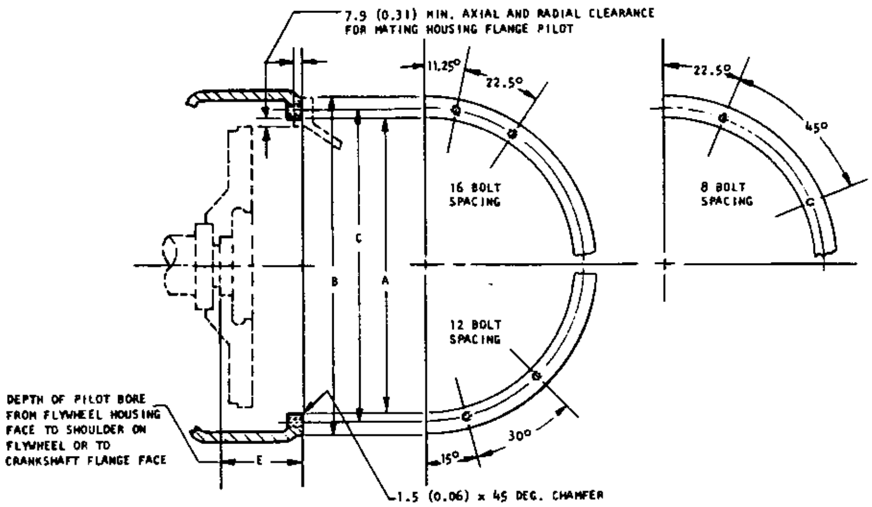
- Engine Flywheel Housing, Section 1.1.3
- Cap Screw Selection, Section 1.1.5
- Starter Requirements, Section 1.1.6.

1.1.3 Engine Flywheel Housing

The first step in adapting the transmission to the engine is to check the housing size, depth, sealing needs, and access openings.

1.1.3.1 Housing Size. SAE No. 3 with a modified pilot is the mounting face on the converter housing of the TT 2000 and TT 3000 series transmissions. SAE No. 2 with a modified pilot is the mounting face on the converter housing of the TT 4000 and CRT 5643 transmissions. SAE No. 1 is used for the mounting face on the transmission housing of the CRT 5633. Therefore, these transmissions can be adapted to engines with matching SAE flywheel housing sizes. Table 1.1-3 lists the various standard SAE flywheel housing sizes and dimensions.

Table 1.1-3 SAE engine flywheel housing specifications



Applicable Transmission	SAE No.
CRT 5633	1d
T(R)T 4000, CRT 5643	2
T(R)T 2000, T(R)T 3000	3

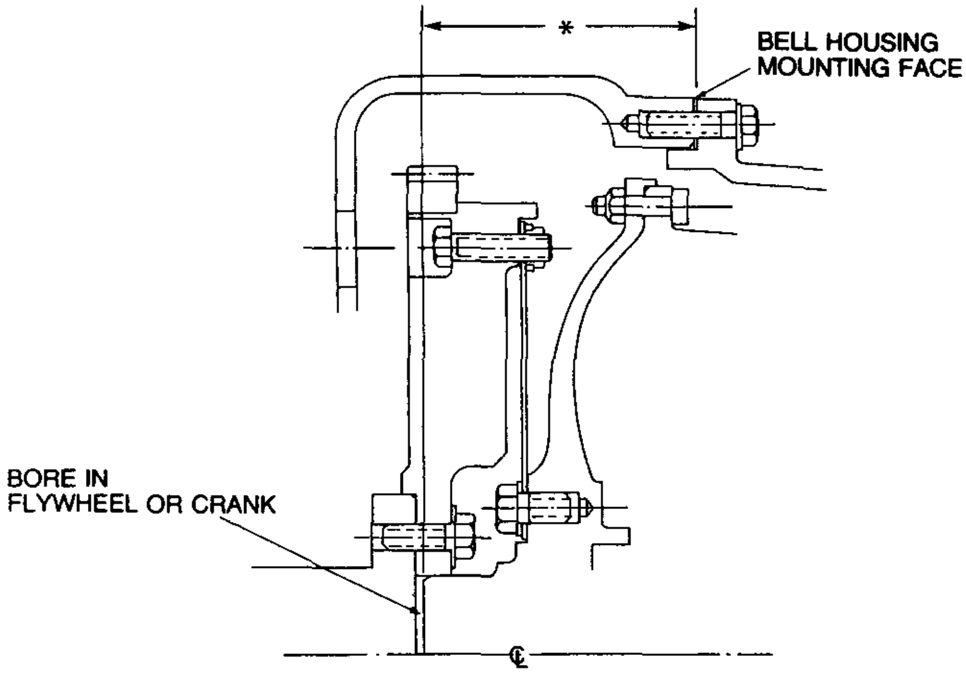
Reference: **1980 SAE Handbook,** J617c, page 41.158.

In making the flywheel-housing to transmission-housing adaptation, relatively close tolerances must be maintained for runout and concentricity of the flywheel housing with respect to the crankshaft centerline:

- The diameter of the bore in the housing should be the same as the SAE transmission housing with tolerance of minus 0.000 to plus 0.127 mm (0.005 in).
- The housing pilot diameter which accepts the pilot of the transmission or converter housing shall be concentric and square with the axis of the crankshaft within .51 mm (0.020 in.) Total Indicator Reading (TIR).
- The housing mounting face shall be square with the axis of the mounting face of the crankshaft within .51 mm (0.020 in.) TIR.

When the engine-flywheel housing does not conform to the appropriate SAE standards, an adapter may be required between the engine and converter or transmission. This adapter is usually supplied by the engine manufacturer and should satisfy the design requirements with respect to the transmission and engine-flywheel housing.

1.1.3.2 **Housing Depth.** Housing depth must be sufficient to fully enclose the transmission converter cover, starter ring gear, and flexdrive mechanism. The clearance requirements for the mounting-face to converter-cover pilot diameters for the various cycling transmission series are shown in Figure 1.1-3.



Flywheel Housing Clearance Requirement

T(R)T 2000	94.14-98.50 mm	(3.706-3.878 in.)
T(R)T 3000	94.14-98.50 mm	(3.706-3.878 in.)
T(R)T 4000	94.74-97.90 mm	(3.730-3.854 in.)
CRT 5633	Ref: 100.00 mm	(3.94 in.)
CRT 5643	Ref: 128.41 mm	(5.06 in.)

Figure 1.1-3 Clearance requirement for flywheel housing

1.1.3.3 **Sealing Requirements.** There are two types of transmission converter housing environments: 1) DRY, and 2) WET. The TT 2000 offers either environment, but the TT 3000, TT 4000, CRT 5633 and CRT 5643 transmissions have only WET converter housings.

1) Dry-housing Requirements: TT 2000 series transmissions may have an optional DRY converter housing incorporating a diaphragm-type seal which prevents oil mist and other transmission component lubrication oil from collecting in the engine or adapter housing. Consequently, housing face gaskets, starter face gaskets, and double crankshaft seals are not required. Figure 1.1-4 illustrates the dry housing seal construction.

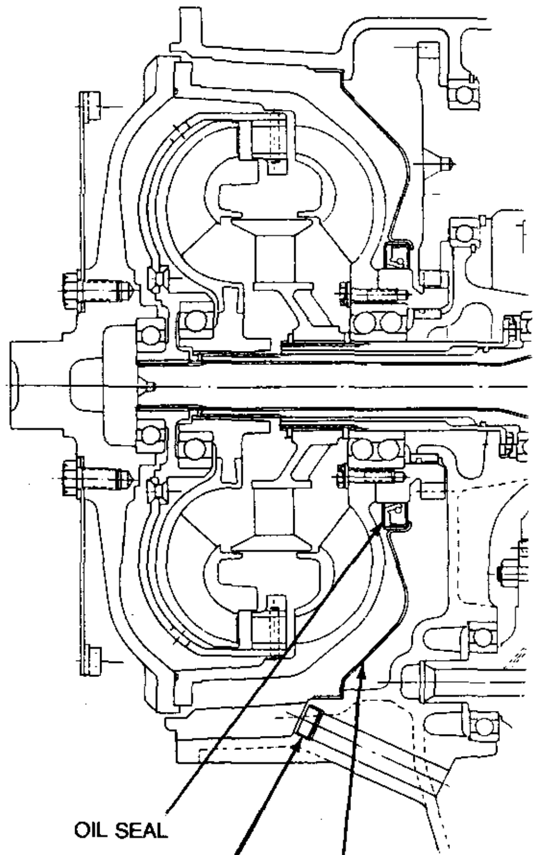


Figure 1.1-4 SAE engine-to-transmission adaptation for the dry housing

2) Wet-housing Requirements: The TT 2000, TT 3000, and TT 4000 series transmissions have a WET converter in which a slight mist of oil is permitted to escape into the engine-flywheel housing area. This oil lubricates various accessory drive gears and customer-furnished PTO units. Oil is returned to the sump by gravity.

The CRT 5633 and CRT 5643 also have WET converter housings. Oil is allowed to escape into the engine-flywheel housing at the approximate rate of four gallons per minute. On the CRT 5633, the oil lubricates accessory drive gears and customer-furnished power take-off units. An input-driven scavenge pump returns the surplus oil to the sump. On the CRT 5643, the oil flows to the sump by gravity.

The WET transmission convertor housing unit requires an engine flywheel housing gasket and an engine flywheel housing drain hole to the converter housing. DDA also recommends a sealed starter and a double seal on the crankshaft. However, engine manufacturers provide a means of sealing engine oil from transmission oil appropriate to their specific design. Openings in the flywheel housing for access to flexdrive bolts should be sealed with a pipe plug or with gasket and bolt-on cover. Figure 1.1-5 illustrates these sealing requirements.

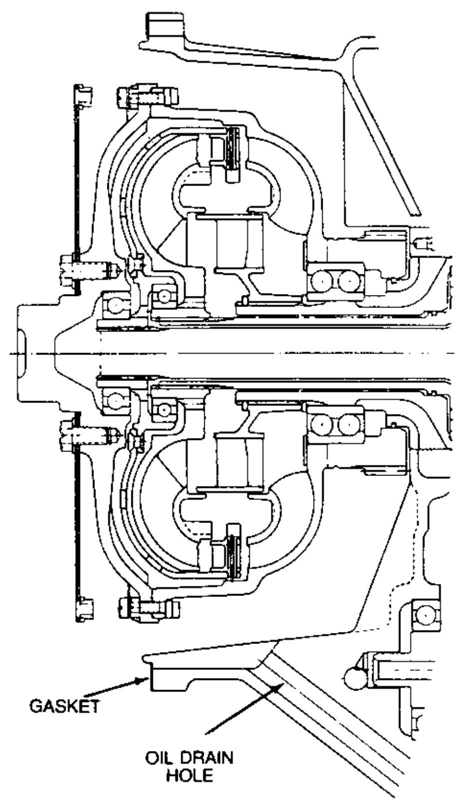


Figure 1.1-5 SAE engine-to-transmission adaptation for the wet housing

1.1.3.4 **Flexdrive Bolt Access.** A flexdrive coupling is available on the various engine-mounted cycling transmissions. This type of coupling requires an access opening on the front or side of the engine-flywheel housing to attach the flexdrive after the flywheel housing and the converter housing have been bolted together. Seal gaskets for either front or side access cover plates are required for a WET converter-flywheel housing.

When a front access is used, an adequate opening must be provided to install and tighten the flexdrive cap screw to the specific torque. The recommended minimum for access is a 38 mm (1.50 in.) diameter hole located on the outer-diameter bolt circle of the flexplate. Refer to Figure 1.1-6 flexdrive illustration and Table 1.1-1 for dimensions and diameters of the flexplates used with the various cycling transmissions.

When it is impractical to provide a front-access, a side access can be provided in the engine flywheel housing. Many times a special-depth flywheel housing or a spacer housing is required to provide the side access to the flexdrive fastener. Figure 1.1-7 illustrates a typical side access configuration.

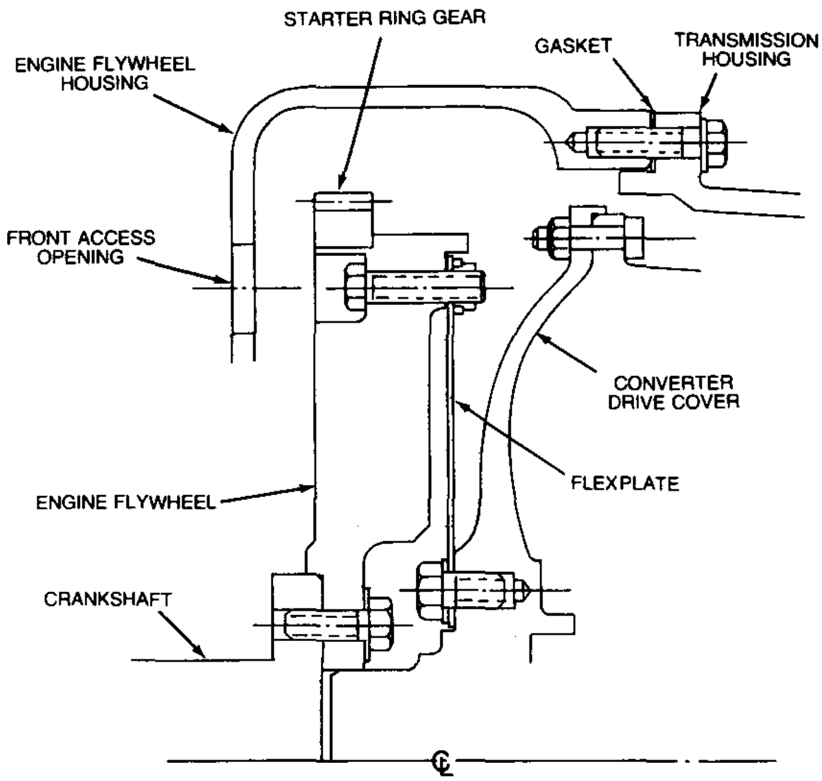


Figure 1.1-6 Typical flexdrive with front access opening

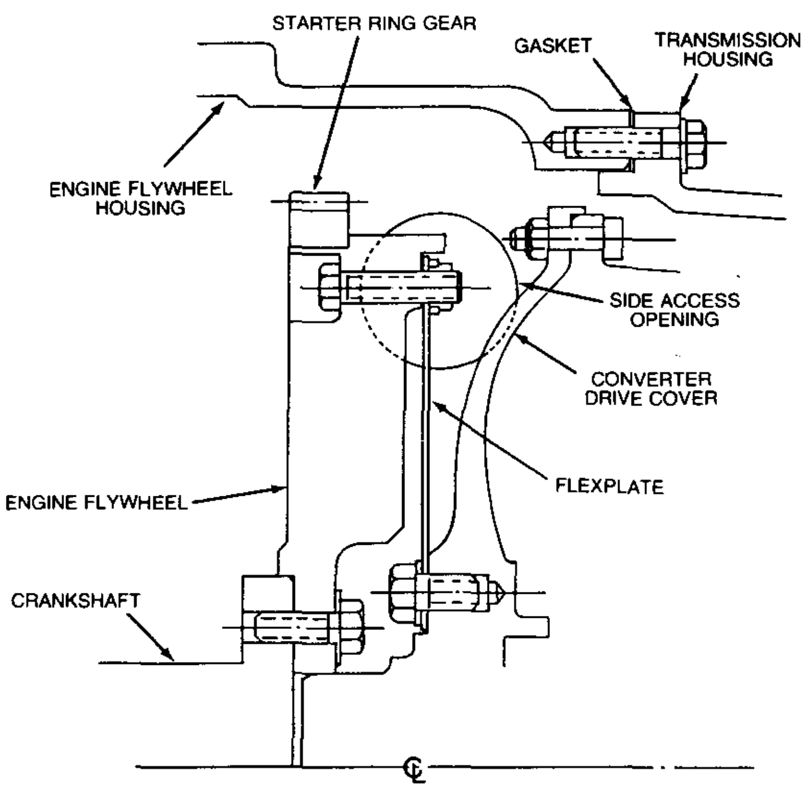


Figure 1.1-7 Typical flexplate drive with side access opening

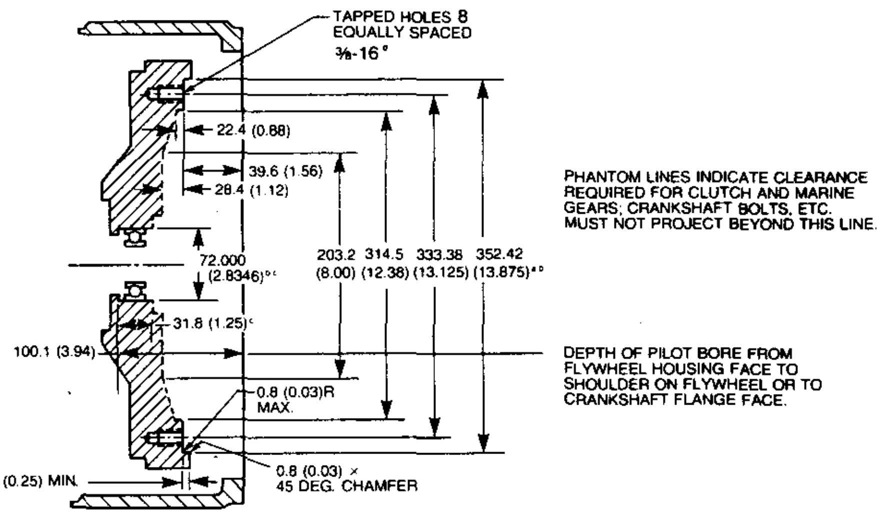
1.1.4 Drive-ring Coupling, T(R)T 2000 Series Only

The drive-ring coupling, a large diameter spline, provides a means of transmitting engine power to the T(R)T 2000 series transmission for installations which cannot use the flexdrive coupling.

This coupling arrangement is less desirable because it can transmit thrust into the engine or converter. We discourage use of this configuration without thorough analysis of the thrust transmitted in a particular installation. Table 1.1-4 shows the drive-ring adaptation requirements for the T(R)T 2000 series transmissions. The drive-ring coupling is described below:

- Engine flywheel with starter ring gear has an inside pilot diameter for mounting the drive member (internal gear).
- Drive member (external gear) is the converter-drive cover with pilot at flywheel inside diameter or mating gear pitch diameters.
- Seal ring for spline grease retention.

Table 1.1-4 Flywheel drive-ring adaptation requirements for TT 2000



NOTE: Suggested tolerances are to be measured on assembled engine; for measuring procedure, see SAE J1033.

[a]Diameter tolerance of driving-ring pilot bore [352.42 (13.875)] is plus 0.13 (0.005), minus 0.000; maximum eccentricity is 0.13 (0.005) total indicator reading (see footnote b); face runout maximum total indicator reading is 0.0005 times the measured diameter. Diameter tolerance for mating driving ring, etc. pilot diameter is plus 0.000, minus 0.13 (0.005).

[b]Eccentricity between driving-ring pilot bore [352.42 (13.875)] and pilot bearing bore [72.000 (2.8346)] is not to exceed 0.20 (0.008) total indicator reading.

[c]The length of bore for pilot bearing is 31.8 (1.25); the nominal diameter of bearing is 72.000 (2.8346). Diameter and fit are to suit installation. Maximum eccentricity is 0.13 (0.005) total indicator reading. (See footnote b).

[d]Tapped holes shall be threaded in accordance with UNC Class 2B tolerances of ANSIB1.1 screw threads, and the minimum length of thread engagement shall be 1.5 times the nominal diameter.

Reference: **1980 SAE Handbook,** J620d, page 41.164.

1.1.5 Cap Screw Selection

Cap screws must be selected for maximum strength and torque retention. Experience indicates that cap screws conforming to the SAE Grade-8 Specifications listed below satisfy these fastener requirements:

Tensile Strength:		1034.25 MPa (150,000 psi) minimum
Yield Strength:		827.4 MPa (120,000 psi) minimum
Hardness:	Brinell 302-352	
	Rockwell C32-C38	
Chemical:	Phosphorus	.04 percent maximum
	Sulfur	.04 percent maximum

Material, Heat Treatment:

Medium carbon, fine grain, alloy steel that provides a minimum oil-quenched hardness of 47 Rc at the center of the bolt thread, one bolt diameter from the end, tempered at a minimum of 427°C (800°F).

Tightening recommendations for converter housing and flexdrive bolts are listed in Table 1.1-5, Torque specifications for bolts and cap screws. Table 1.1-6 gives the axial loads for SAE grade-8 bolts and cap screws of various sizes when torqued to produce 448.175 and 689.5 kPa (65,000 and 100,000 psi) nominal stress. These figures are based on inch series threads that are neither plated nor lubricated and have average machined surfaces. The stresses are based on the sections at the root dimension.

The converter housing, flexdrive, and/or drive ring, are subjected to torque reversals due to engine torsionals, and acceleration or deceleration. Therefore, the clamping force across these joints must be sufficient to prevent slipping. Table 1.1-1 lists the flexplate dimensions needed to calculate the required clamping force coefficient.

The coefficient of friction required to prevent slippage between twomating parts depends on several factors. These factors are related by the following expression:

$T = NF\mu R$, where:

T = Maximum static torque (usually corresponds to the maximum input rating of the converter or transmission), N·m (lb-ft).

N = Number of bolts

F = Total compressive axial force per bolt (obtained from Table 1.1-5), N (lb).

μ = Required friction coefficient

R = Bolt circle radius, M (ft).

A major consideration in calculating the friction coefficient is the clamping force (per bolt) exerted on the joint as the bolt is tightened to a specific torque. Variation in thread friction is usually extensive; therefore, the maximum recommended friction coefficient requirements must be qualified according to the method used to determine the coefficient.

Experience indicates that using the above formula, per the example following, the calculated friction coefficient should not exceed .02 which includes a 5 to 1 factor for torsional activity.

EXAMPLE: Calculaté the required friction coefficient for the TT 2221-1 cycling transmission.

CAUTION: Do not mix Metric and Inch Series Units in basic relationship.

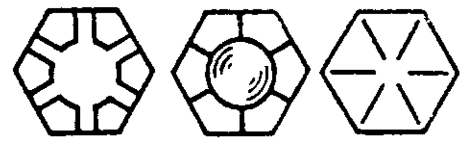
Basic Relationship: $T = NF\mu R$

Rearranged: $\mu = \frac{T}{NFR}$

T = 420 N·m (310 lb-ft)
N = 8
F = 23 350 N (5,250 lbs), Bolt Size = 3/8 - 24
R = .17 m (.547 ft)

$$\mu = \frac{420}{8 \times 23\,350 \times .17} = .013$$

Table 1.1-5 General torque specifications, bolts and cap screws



Size	Threads per in.	GRADE 5 Standard heat-treated bolts and screws			GRADE 8 Special heat-treated bolts, screws, Allen-head screws, and self-locking cap screws		
		lb ft	N·m	kg·m	lb ft	N·m	kg·m
.25 (1/4)	20	6-8	8.1- 10.8	.83- 1.11	9-11	12.2- 14.9	1.24- 1.52
	28	8-10	10.8- 13.6	1.11- 1.38	10-12	10.8- 16.3	1.38- 1.66
.3125 (5/16)	18	15-18	20.3- 24.4	2.07- 2.49	17-20	23.0- 27.1	2.35- 2.77
	24	17-20	23.0- 27.1	2.35- 2.77	19-23	25.8- 31.2	2.63- 3.18
.375 (3/8)	16	26-32	35.3- 43.4	3.59- 4.42	36-43	48.8- 58.3	4.98- 5.94
	24	33-40	44.7- 54.2	4.56- 5.53	41-49	55.6- 66.4	5.67- 6.77
.4375 (7/16)	14	42-50	57.0- 67.8	5.81- 6.91	54-65	73.2- 88.1	7.47- 8.99
	20	50-60	67.8- 81.3	6.91- 8.30	64-77	86.8- 104.4	8.85- 10.65
.5 (1/2)	13	67-80	90.8-108.5	9.26-11.06	81-97	109.8- 131.5	11.20- 13.41
	20	83-100	112.5-135.6	11.48-13.83	96-115	130.2- 155.9	13.27- 15.90
.5625 (9/16)	12	85-100	115.2-135.6	11.75-13.83	103-123	139.6- 166.8	14.24- 17.01
	18	100-120	135.6-162.7	13.83-16.59	122-146	165.4- 197.9	16.87- 20.19
.625 (5/8)	11	117-140	158.6-189.8	16.18-19.36	164-192	222.4- 260.3	22.67- 26.54
	18	134-160	181.7-216.9	18.53-22.12	193-225	261.7- 305.1	26.68- 31.11
.75 (3/4)	10	180-210	244.0-284.7	24.89-29.03	284-325	385.1- 440.6	39.26- 44.93
	16	215-250	291.5-339.0	29.72-34.56	337-385	456.9- 522.0	46.59- 53.23
.875 (7/8)	9	315-360	427.1-488.1	43.55-49.77	490-550	664.4- 745.7	67.74- 76.04
	14	372-425	504.4-576.2	51.43-58.76	575-650	779.6- 881.3	79.50- 89.87
1 (1)	8	445-500	603.3-677.9	61.52-69.13	685-770	928.7-1044.0	94.70-106.46
	14	535-600	725.4-813.5	73.97-82.95	830-925	1125.3-1254.1	114.75-127.89

These figures are based on inch series threads that are neither plated nor lubricated and have average machined surfaces.

Table 1.1-6 Axial loads for SAE grade 8 bolts and cap screws

SAE GRADE-8 BOLT			TORQUE*		AXIAL LOAD*		TORQUE**		AXIAL LOAD**	
Size in Inches Decimal	(Fraction)	Threads per in.	Newton-meters	Pound-feet	Newtons	Pounds	Newton-meters	Pound-feet	Newtons	Pounds
.25	(1/4)	20	11	8	7780	1750	15	11	11,960	2690
		28	14	10	9340	2100	16	12	14,500	3260
.3125	(5/16)	18	24	18	13,120	2950	27	20	20,190	4540
		24	27	20	15,120	3400	31	23	23,310	5240
.375	(3/8)	16	43	32	19,570	4400	58	43	30,160	6780
		24	54	40	23,350	5250	66	49	35,980	8090
.4375	(7/16)	14	68	50	26,910	6050	88	65	41,500	9330
		20	81	60	31,580	7100	104	77	48,480	10,900
.5	(1/2)	13	108	80	36,250	8150	132	97	55,910	12,570
		20	136	100	42,920	9650	156	115	66,100	14,860
.5625	(9/16)	12	136	100	46,700	10,500	167	123	72,060	16,200
		18	163	120	54,710	12,300	198	146	83,980	18,880
.625	(5/8)	11	186	140	58,710	13,200	260	192	89,760	20,180
		18	216	160	69,390	15,600	305	225	106,730	24,000
.75	(3/4)	10	285	210	87,180	19,600	441	325	134,330	30,200
		16	339	250	101,410	22,800	522	385	156,260	35,130
.875	(7/8)	9	488	360	120,990	27,200	746	550	186,500	41,930
		14	576	425	139,220	31,300	881	650	213,720	48,050
1		8	678	500	159,240	35,800	1044	770	245,100	55,100
		14	813	600	186,820	42,000	1254	925	287,520	64,640

* @ 448.175 MPa (65,000 psi) stress.

** @ 689.5 MPa (100,000 psi) stress.

These figures are based on inch series threads that are neither plated nor lubricated and have average machined surfaces. The stresses are based on the sections at the root dimension.

1.1.6 Starter Requirements

Although applications with torque converters and torque converter-type transmissions add an additional load on the engine starters, the major engine manufactuers indicate their standard starters have sufficient capacity.

The viscous oil drag of the converter charging pump and input-driven accessories, such as power takeoff and hydraulic pump, creates a relatively insignificant additional starting load as compared to the requirements of the engine and its accessories.

1.2 TRANSMISSION MOUNTING

After the suitable engine-transmission adaptation has been determined, the mounting system for the installation of the powertrain must be designed. This section describes acceptable mounting systems for the off-highway cycling transmissions. An acceptable mounting system:

- supports the transmission weight without imparting undue loads on internal components.
- absorbs the vehicle driveline reaction torques.
- compensates for frame twist or deflection without applying loads to the transmission housings. The transmission is not a structural member of the vehicle frame.
- absorbs excess shock loads caused by vehicle impacts.
- locates and maintains the position of the transmission to assure driveline angularity requirements relative to the engine and vehicle drive members.
- provides vibration damping between the powertrain and the vehicle frame.

Typically, these functions are accomplished by a three-point mounting support with the proper isolation as shown in Figure 1.2-1, Cradle-mount installation of the engine and transmission. Provisions in the mounting system for twisting or reduction of shock forces are not a major consideration in stationary installations.

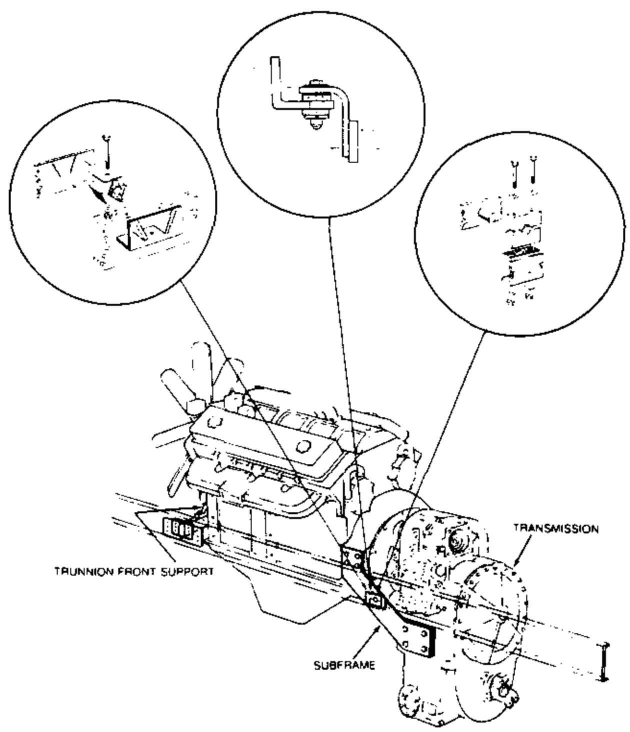


Figure 1.2-1 Cradle-mounting installation of engine and transmission

1.2.1 Transmission Mounting Systems

The following application parameters determine the type of transmission mounting system to be used:

- type of vehicle
- anticipated work cycle
- vehicle operating terrain
- engine-transmission adaptation
- transmission dropbox configuration

The following table indicates proven types of installation mountings for the various series of Allison cycling transmissions:

	Direct to Engine		Remote Mounted	
Series	Angle Bracket	Cradle	Angle Bracket	Trunnion
T(R)T 2200	X	X	X	
T(R)T 2400	X	X	X	X
T(R)T 3000	X	X	X	X
T(R)T 4000	X	X	X	
CRT 5633		X		X
CRT 5643		X		

In many cases two or more configurations are applicable to the same transmission. The selection depends upon the application. The cradle mounting provides the best support for engine-mounted transmissions in vehicles operating on rough terrain. The angle brackets are used on remote-mounted units in either vehicles or in stationary applications. A front trunnion is available on the remote-mounted T(R)T 2400 and T(R)T 3400 transmissions, but is not required for any remote applications of these transmissions. The CRT 5633 trunnion mount must be used in all remote applications. Mounting with similar angle brackets can be used with direct adaptations also, but are recommended only for vehicles operating on relatively flat terrain and in stationary applications.

Refer to the following cycling transmission Installation Drawings for the exact locations of the provided mounting pads:

Transmission Models	Installation Drawing
TT 2000-1	AS 22-003
TRT 2000-1	AS 22-017
TRT 2000-3	AS 22-016
TRT 2010-3	AS 22-021
TT 3000-1	AS 32-001
TRT 3000-1	AS 32-008
TT 4721-1	AS 42-015
TRT 4821-1	AS 42-015
CRT 5633 Loader Version	AS 56-015
CRT 5633 Nonloader Version	AS 56-016
CRT 5633-7 Straight-through Version*	AS 56-017
CRT 5643	AS 56-024

* The supplier of the rear cover or transfer case must provide mounting pads for the straight-through CRT 5633 as shown on AS 56-017.

1.2.1.1 Direct Engine Mount Using Full Frame Cradle. Experience shows that installation of transmissions directly to the engine using a full cradle support is more reliable in vehicles operating over rough terrain. A subframe on each side of the powertrain is bolted to the engine flywheel mounting pads and to the transmission side-mounting pads. The subframe is connected through rubber isolation pads or other resilient supports to the vehicle main frame. The front of the engine on a trunnion completes the three point mounting system, which is minimally affected by frame twist in any plane. Refer to the illustration in Figure 1.2-1 Engine-transmission cradle mounting.

The mounting point between the sub and main frame must be so located that moment forces at the splitline of the engine and engine flywheel housing is minimized and conforms to the engine manufacturer's recommendations. Refer to Figure 1.2-2 Procedure for determining location of cradle mounts to main frame support. Table 1.2-1 provides the transmission data necessary for these calculations. Consult the engine manufacturer on design questions to reduce flywheel housing stresses.

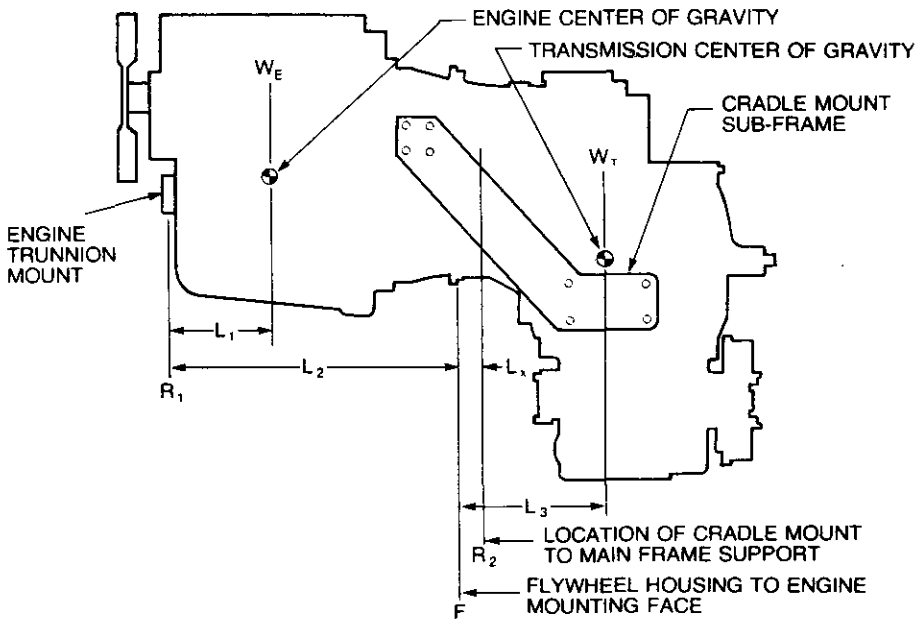


Figure 1.2-2 Procedure for locating cradle mounts on main frame

Data Required: Location of centers of gravity, installed weights of engine and transmission, location of front trunnion mount of engine, and location of flywheel housing mounting face.

Formula Legend:

W_E = Weight Engine
W_T = Weight Transmission at center of gravity.
R_1 = Reaction at engine trunnion
R_2 = Reaction at cradle mount on main frame support.
F = Force at engine flywheel housing mounting face.
L_X = Location of cradle support to obtain zero bending moment at engine flywheel housing mounting face.

Calculations

1. $W_E L_1 = F L_2$

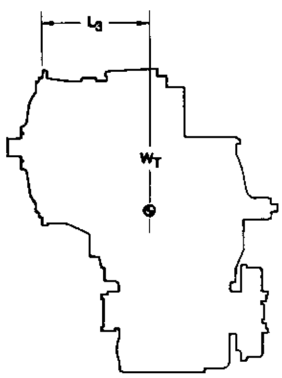
$$F = \frac{W_E L_1}{L_2}$$

2. $R_2 = F + W_T$

3. $L_X R_2 = W_T L_3$

$$L_X = \frac{W_T L_3}{R_2}$$

Table 1.2-1 Calculation data for cradle mount location



L_3 = axial C.G. Location from mounting face
W_T = Weight Transmission

Transmission Models	Estimated Maximum Transmission Weight kg	lb	Estimated Axial Center of Gravity Location from Mounting Face mm	in.
TT 2221-1	345	760	320.5	12.6
TT 2421-1	352	775	315.5	12.4
TTB 2221-1	429	945	327.7	12.9
TTB 2421-1	435	960	325.1	12.8
TRT 2221-1	412	910	345.4	13.6
TRT 2421-1	420	925	345.4	13.6
TRT 2211-3	295	660	279.4	11.0
TRT 2411-3	306	675	279.4	11.0
TRT 2221-3	342	755	384.8	15.2
TRT 2421-3	349	770	384.8	15.2
TT 3420-1	404	890	325.8	12.8
TRT 3420-1	469	1035	382.7	15.1
TRT 3220-1	462	1020	386.1	15.2
TT 4720	701	1545	409.4	16.1
TRT 4820	767	1690	409.4	16.1
CRT 5633 (transfer drive)	1090	2398	428.8	16.9
CRT 5643	1144	2522	571.5	22.5

1.2.1.2 **Direct Engine Mount Using Angle Brackets.** Transmissions are installed using angle brackets in stationary applications or in vehicles that operate on relatively flat terrain. The engine is mounted on a front trunnion, and the transmission is supported with angle brackets bolted to its side mounting pads and the vehicle main frame. An isolator pad installed between these members helps absorb drive train vibrations. Figure 1.2-3 illustrates this arrangement.

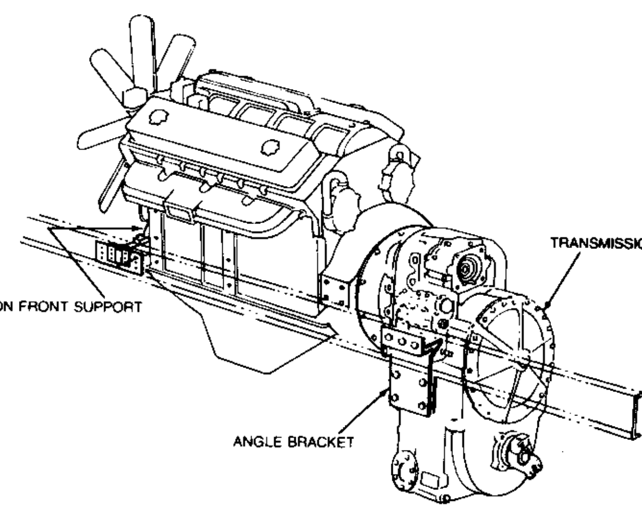


Figure 1.2-3 Engine trunnion and transmission angle bracket mountings

1.2.1.3 **Remote Mounting.** The center of gravity of the Twin Turbine transmission falls within the span of the side-mounting pad holes, therefore angle brackets will provide the support required. The CRT 5633 requires a front trunnion concentric with the input flange, while the rear is supported by angle brackets bolted to its side-mounting pads and the main frame when it is installed remotely. The T(R)T 2400 and T(R)T 3400 models also have provision for trunnion support.

A typical trunnion mount is illustrated in Figure 1.2-4. Detail dimensions for trunnion mounting diameters and supports are included on the transmission installation drawings and AS 00-003. Also included are various methods of designing trunnion supports.

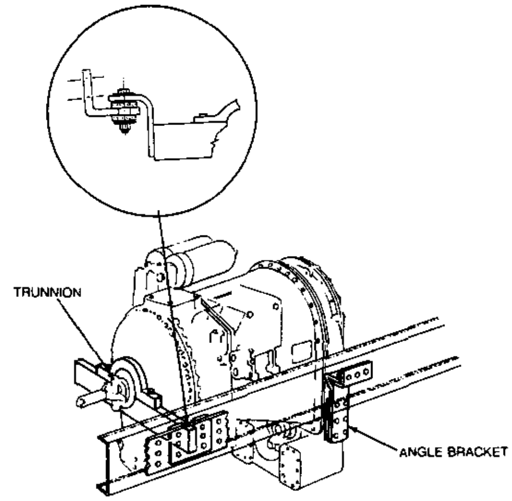


Figure 1.2-4 Front trunnion and rear angle bracket mounting of CRT 5633 and CRT 5643 cycling transmissions

In instances where a great deal of frame deflection or linear vibration from drivelines are present, excessive wear at the trunnion bore diameter can occur. A phenolic bushing or a full-round length of 'V' belt installed in a groove in the trunnion bore may be used to support the weight of the transmission, thus reducing wear.

One of the design requirements for a trunnion support is that excessive diametral tightening of the split-type trunnion-mount members be avoided to prevent "squeezing", a condition which can cause damage to the transmission input drive bearing. The transmission installation and trunnion support drawings specify the clearance that should be maintained between the transmission pilot diameter and inside diameter of the trunnion after installation to prevent "squeezing".

It is recommended that rubber isolation pads be used between the trunnion member and the vehicle frame.

1.2.2 Mounting Considerations

1.2.2.1 **Mounting Members.** Channel sections and brackets of low-carbon steel, welded or bolted together, are generally used as mounting members. The bracket size depends on the geometry and weight of the transmission. As a general guide, 127 mm (.500 in.) steel plate is used for the Twin Turbine transmissions; and 188 mm (.750 in.) for the CRT 5633 and CRT5643.

Mounting pads with full-thread holes, .625-11 UNC-2B inch series threads, 26.4 mm (1.04 in.) minimum depth, are provided on both sides of the transmission for bolting the mounting brackets. Bolts or cap screws should conform to SAE Grade 8 specifications. The transmission contains blind drilled and tapped holes one and one-half times as deep as the bolt diameter for engagement of threads. Review the installation drawing to prevent bolt interference at bottom of the tapped hole.

1.2.2.2 **Isolators.** DDA recommends installation of rubber isolation pads between the trunnion member and vehicle frame. Whether the transmission is mounted directly to the engine or mounted remotely, isolation must be a prime consideration. The isolator pads, biscuits, or bushings reduce shock forces and help absorb vibration from the power train and drivelines. Also isolator pads are very beneficial for reducing noise levels since the damping characteristics tend to eliminate or reduce excitation of other component parts of the vehicle. An isolator manufacturer, such as Lord Manufacturing Company, may be consulted on questions of proper isolation design.

1.2.3 Transmission Attitude

When establishing the installation attitude, transmission positioning in the vehicle, the major concern must be the resulting driveline angularity. Driveline requirements are explained in Section 1.4.

Angles other than true horizontal, fore and aft, and true vertical, side to side, are permissible in the installation of a transmission provided the true tilt angles of maximum operation are not exceeded. Maximum tilt angles for intermittent operations, including chassis installation angles and terrain slopes, have been analytically determined and are listed below. These angles serve as a guide only. Installations involving large tilt angles should be evaluated for the specific application.

T(R)T 2/3000 total installation and operating angles are as follows:

True Angle	Direction of Tilt
65°	left (rear view, counterclockwise)
35°	right (rear view, clockwise)
30°	forward
20°	rearward

T(R)T 4000 total installation and operating angles are as follows:

True Angle	Direction of Tilt
35°	left (rear view, counterclockwise)
65°	right (rear view, clockwise)
30°	forward
20°	rearward

The Tilt angles for the CRT 5000 are unavailable at this time.

1.3 FLANGE PROVISIONS

Optional drive flanges are available depending upon the requirements of the engine and transmission adaptations for specific vehicle installations. Since flange selection and design effects the mounting pad-to-flange face dimensions, the following Installation Drawings list these dimensions for the input and output flanges available on the various cycling transmissions:

Transmission Series	Installation Drawings
T(R)T 2000	AS 22-008
T(R)T 3000	AS 22-008
T(R)T 4000	AS 00-011
CRT 5000	AS 58-035

1.3.1 Input Flanges

Remote-mounted installations require input drive flanges. Transmissions are available without an input flange for installations involving unique driveline flange requirements where the vehicle manufacturer fabricates the special input flange.

Special input flange designs for the transmission interface must meet DDA specifications and be approved by the DDA Transmission Engineering Applications department. In addition, flange design must have sufficient torque capacity to withstand the maximum rated input torque for the transmissions, as published in the PRODUCT DESCRIPTIONS of the various models. In addition, engine manufacturers should be consulted to include an appropriate factor of safety for torsional activity.

Particular engine and driveline configurations may require an input vibration damper. A TORQMATIC® coupling, rubber damper, is available for the TT series remote-mounted transmissions. A damper is not available for CRT 5633 or CRT 5643 transmissions. Considerations necessary to evaluate and determine the requirement of a damper are discussed in Section 1.5 TORSIONAL VIBRATION.

*Special rating for heavy-duty applications such as wheel and tracked dozers.

1.3.2Output Flanges

Output flanges of various sizes and configurations are available. Refer to the above Section 1.3 for the Installation Drawings numbers which list flanges available for each transmission model, as well as the different mounting pad-to-flange face dimensions for the various configurations.

Transmissions for installations requiring special flange designs may be ordered without flanges. Special output flanges must meet transmission interface requirements as indicated on the following Installation Drawings:

Transmission Model	Installation Drawings
T(R)T 2000-1 (long drop)	AS 22-034
TRT 2000-3 (short drop)	AS 22-035
T(R)T 3000-1 (long drop)	AS 32-006
T(R)T 4000-1 (long drop), CRT 5633, and CRT 5643	Contact DDA Transmission Applications Engineering.

Output flange capacity must meet, with a margin of safety, the maximum output torque to be experienced by the transmission.

1.4 DRIVELINES

In order to assure minimum vibration and maximum life of all components of a drive train, particular attention must be given to the design of the driveline. Final approval of a given driveline installation should come from the driveline manufacturer. However in planning the drivetrain layout, close following of the accepted driveline paractices outlined below, will provide the necessary groundwork for successful power train design.

Consider these factors affecting driveline performance:

- maximum driveline torques
- maximum driveline speeds
- lengths and angles of driveline
- effect of vehicle suspension on driveline angles
- mass-elastic systems
- firing frequencies of engine
- sources of cyclic loading on the power train
- vehicle work cycle

A primary goal in the design of a driveline is to minimize the effects of the joint angles by first minimizing the magnitude of the angles of multi-joint drivelines and then by selecting driveline angles which cancel the effects of other joints in the same driveline. Obviously cancellation is impossible in single-joint systems.

Only output drivelines from the transmission to the wheels are involved when the transmission is mounted directly to the engine. Both an input driveline from the engine to the transmission and an output driveline to the axle are involved when the transmission is mounted remotely.

Background information on driveline analysis that applies to both input and output drivelines will be presented first. Then the differing factors affecting input and output drivelines will be discussed separately.

1.4.1 Driveline Shaft Sizing

The driveline shaft length and maximum driveline speed determines the shaft size required to prevent 'shaft whip'. Refer to Figure 1.4-1, Nomogram for selecting input and output driveline sizes from length and speed, to determine required shaft tubing size.

The maximum speed for an input driveline is limited to the input speed rating of each model. The maximum output speed for each model series of cycling transmissions is calculated by using its input speed rating and dividing by the lowest gear ratio of the particular model.

EXAMPLE: TT 3420-1 Gear Ratio

FORWARD LOW F_1 = 2.516
FORWARD HIGH F_2 = .699
REVERSE LOW R_1 = 2.321

MAXIMUM OUTPUT SPEED = $\frac{2800}{.699}$ = 4010 rpm

The shaft must have sufficient capacity to withstand maximum torque. Generally, driveline torque capacity is rated for continuous and intermittent operation and includes a torsional yield limit. These torque limits can be obtained from driveline manufacturers.

For the maximum transmission input torque limits used to estimate shaft sizes when designing input drivelines, refer to Section 1.3.1 Input Flanges. Contact DDA Transmission Applications Engineering and provide the proposed transmission configuration and vocation information for output torque limits.

EXAMPLE OF PROCEDURE:

1. Locate proper shaft length on Line 'A'*
2. Locate maximum driveline speed on Line 'B'
3. Connect points on Lines 'A' and 'B' with straight line (refer to dotted line in example).
4. Read answer on Line 'C' at point of intersection. Tube size must be larger than this to eliminate shaft 'whip'.

* Length 'A': For two-joint assembly, ℄ to ℄ of joints.

For joint and shaft, ℄ of joint to ℄ of center bearing.

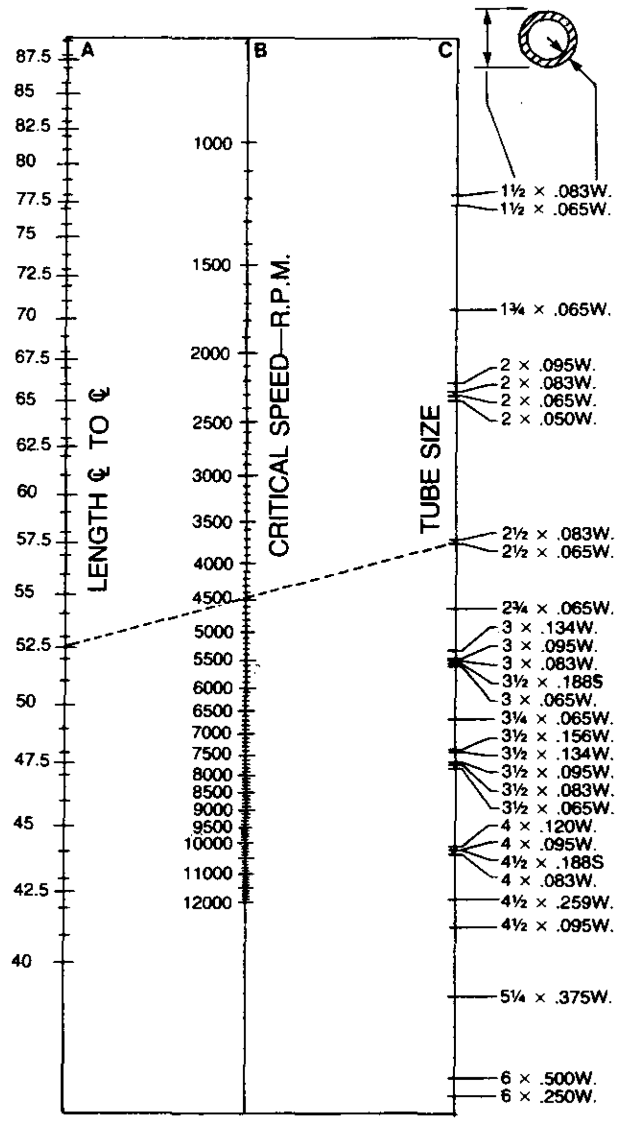


Figure 1.4-1 Nomogram for selecting shaft size from input and output driveline length and speed

1.4.2 Driveline Disturbances (Nonconstant Velocity Joints)

There are two main types of universal joints: the Cardan (cross-type) and constant-velocity type. The Cardan joint is most commonly used; however, in certain cases, the constant-velocity joint may be advantageous. This type joint is generally used where extreme angles cannot be avoided. Since the constant-velocity joint is used in special applications, the remainder of this section is devoted to the more common Cardan driveline.

Associated with the Cardan joint is a phenomenon of nonuniform motion which results from the geometry of the joint itself whenever drivelines are connected at an angle. The Cardan joint geometry produces a sinusoidal angular position, velocity, and acceleration in its driven member for a given constant velocity on the input member. Because the transmission, propshaft, and differential have inertia, accelerating them in this sinusoidal manner creates cyclic torque in the system. These cyclic torques result in torsional vibrations and related problems.

Acceptable limits for each type of disturbance caused by this motion are measured in terms of angular acceleration (rad/sec^2). These limits are based on years of successful industry-wide experience. Specifically, three types of driveline disturbances resulting from this nonuniform motion must be considered:

- Inertial Excitation, torsionals due to acceleration of inertial members.
- Torsional Excitation, torsionals due to total nonuniform driveline motion.
- Secondary Couple Excitation, torsionals due to transfer of torques at an angle.

1.4.2.1 **Inertial Excitation.** This excitation is produced by the oscillating torque loads resulting from the driveshaft inertia being accelerated through nonuniform motion. The accleration of a member is caused by any angle between this driven member and its driving member. Notice in the two-joint driveline in Figure 1.4-2, Examples of complete cancellation, that a fluctuating motion is created from the constant speed of the driveline input driving through an angle. The driveline input can be considered the transmission output or the differential input shaft depending upon whether the vehicle is coasting or driving. When angle A is unequal to angle B, the effects of the joint angles must be considered separatelv. The acceptable limit on the oscillatory motion of the propshaft caused by angle A or B is 500 rad/sec^2 for transmission input drivelines and 1000 rad/sec^2 for transmission output drivelines.

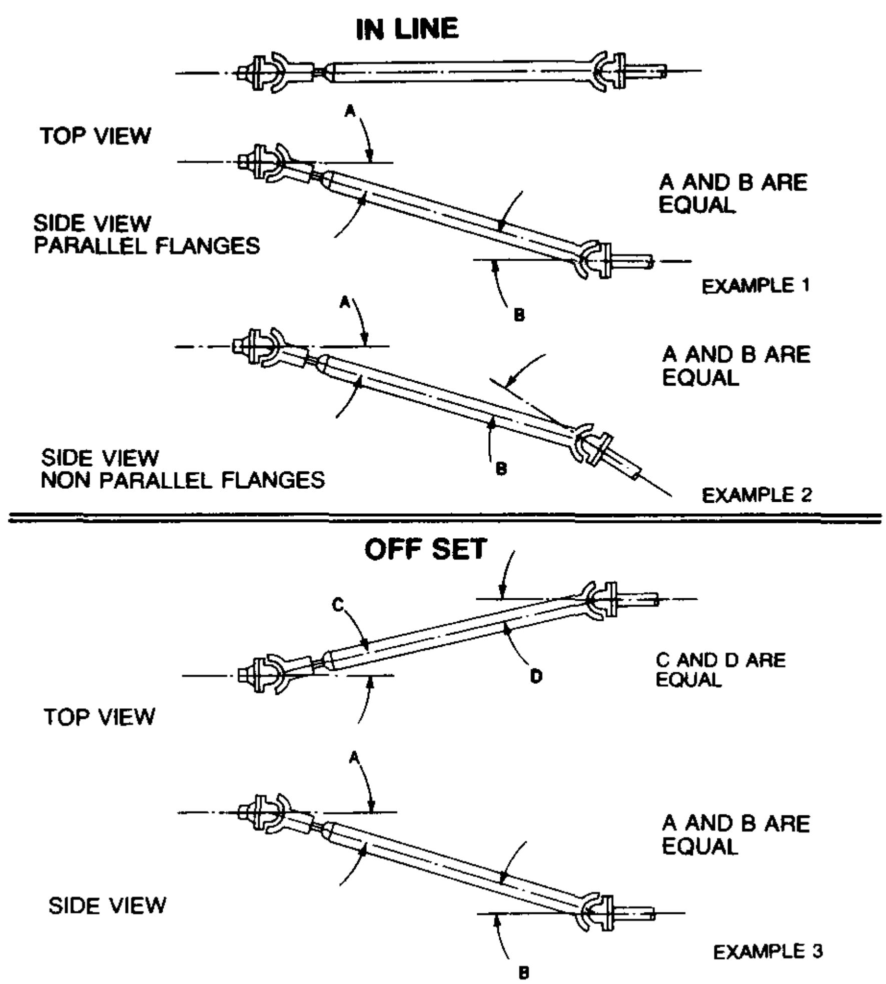


Figure 1.4-2 Examples of complete cancellation of fluctuating motion

1.4.2.2 Torsional Excitations. In a multiple-joint driveline, the nonuniform motion through one joint will be cancelled by this motion being transferred through the last joint at an equivalent angle.

However, due to vehicle limitations, these conditions cannot always be met. A driveline that does not satisfy these requirements will produce nonuniform motion at the output member for a given uniform motion at the input. Since large rotating inertias which resist this fluctuating motion are present at each end of the driveline, deflections within the driveline must accommodate the difference.

Refer to the driveline layouts in Figure 1.4-3, Examples of driveline layouts subject to noncancellation. The analysis used to determine the peak levels of angular acceleration in these cases is similar to that used for the single-joint angle as explained in the inertial excitations. However, torsional excitation is a total additive result of all driveline joints and not merely a result of each individual joint. Experience has shown that angular accelerations caused by noncancellation must be limited to 300 rad/sec^2 for a two-joint output driveline and 500 rad/sec^2 for a three-joint output driveline system. The input driveline should be designed to eliminate angular acceleration of the transmission input members.

As indicated in the preceding paragraphs, it is good engineering practice to keep driveline angles to a minimum since extreme angles induce torsional activity detrimental to the transmission as well as other driveline components. Figure 1.4-4, Allowable angles for input and output drivelines as related to maximum shaft speeds, shows the generally acceptable relationship for driveline speeds and angles.

Equal angles must be maintained at both ends of any propeller shaft so that the nonuniform motion of the shaft will be cancelled. To obtain equal angles for a driveline in which one member of the driveline moves relative to the other, it is necessary that the driveline be installed so that the flanges are parallel. Refer to the illustration at the top of Figure 1.4-2, Examples of complete cancellation. It shows that vertical movement of either flange in this type of driveline will still yield equal angles at A and B.

For vehicle installations using articulated steering, flanges may be rotated through an arc which yields unequal compound angles. This condititition is permissible for intermittent operation, but flange parallelism should be provided for the nominal, straight travel position. Refer to Figure 1.4-5, Acceptable angles for a two-joint driveline without offset, to determine maximum parallelism deviation for continuous operation. The driveline manufacturer should be contacted to determine the maximum driveline speed at an articulated angle to analyze driveline torsionals.

In driveline configurations where both ends are stationary, equal angles can be obtained whether or not the flanges are parallel. The lower diagram in Figure 1.4-5 shows this type of driveline where the flanges remain fixed to ensure equal angles at C and D.

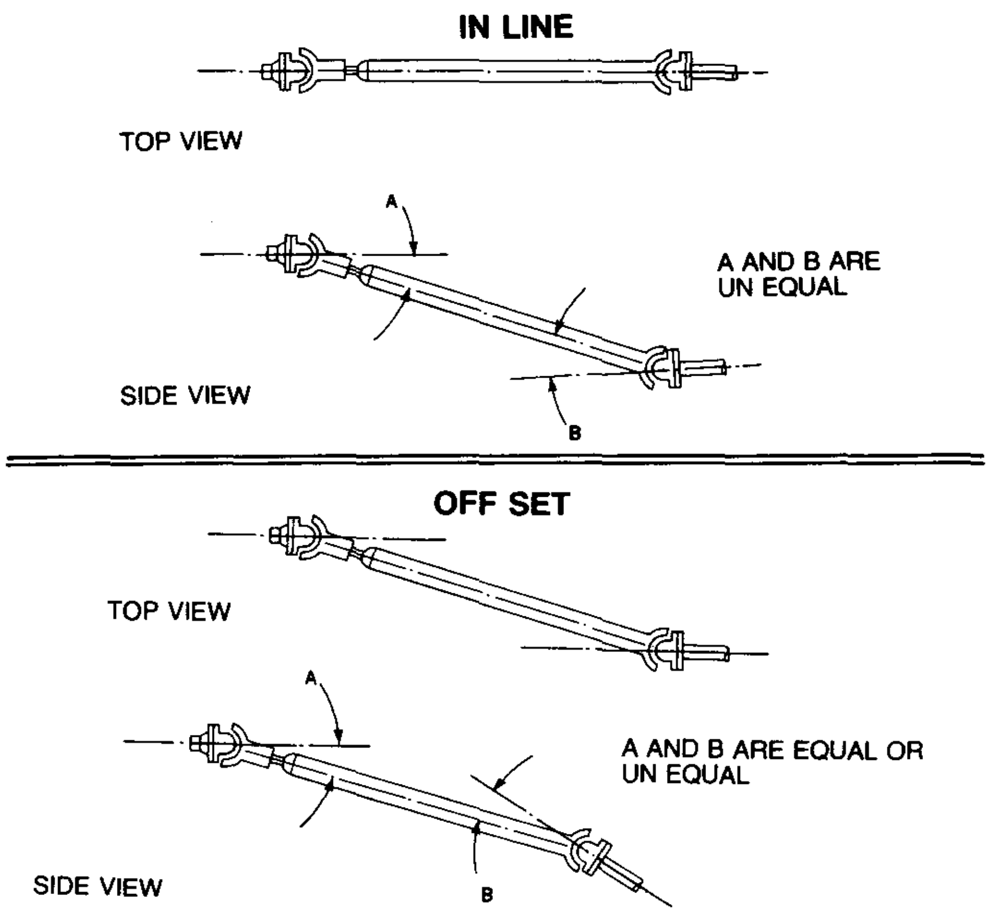


Figure 1.4-3 Examples of driveline layouts subject to noncancellation

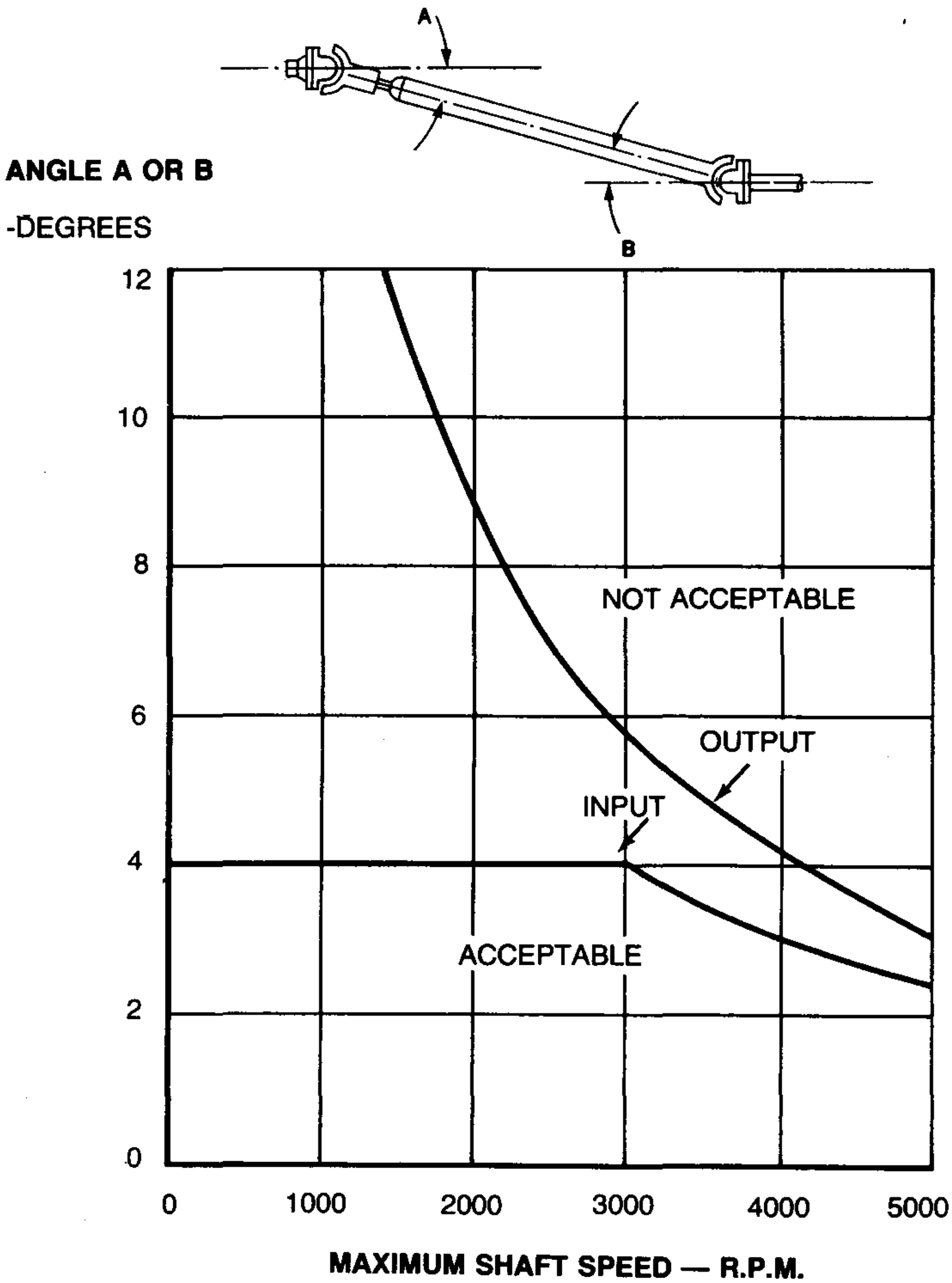


Figure 1.4-4 Allowable angles for input and output drivelines as related to maximum shaft speeds

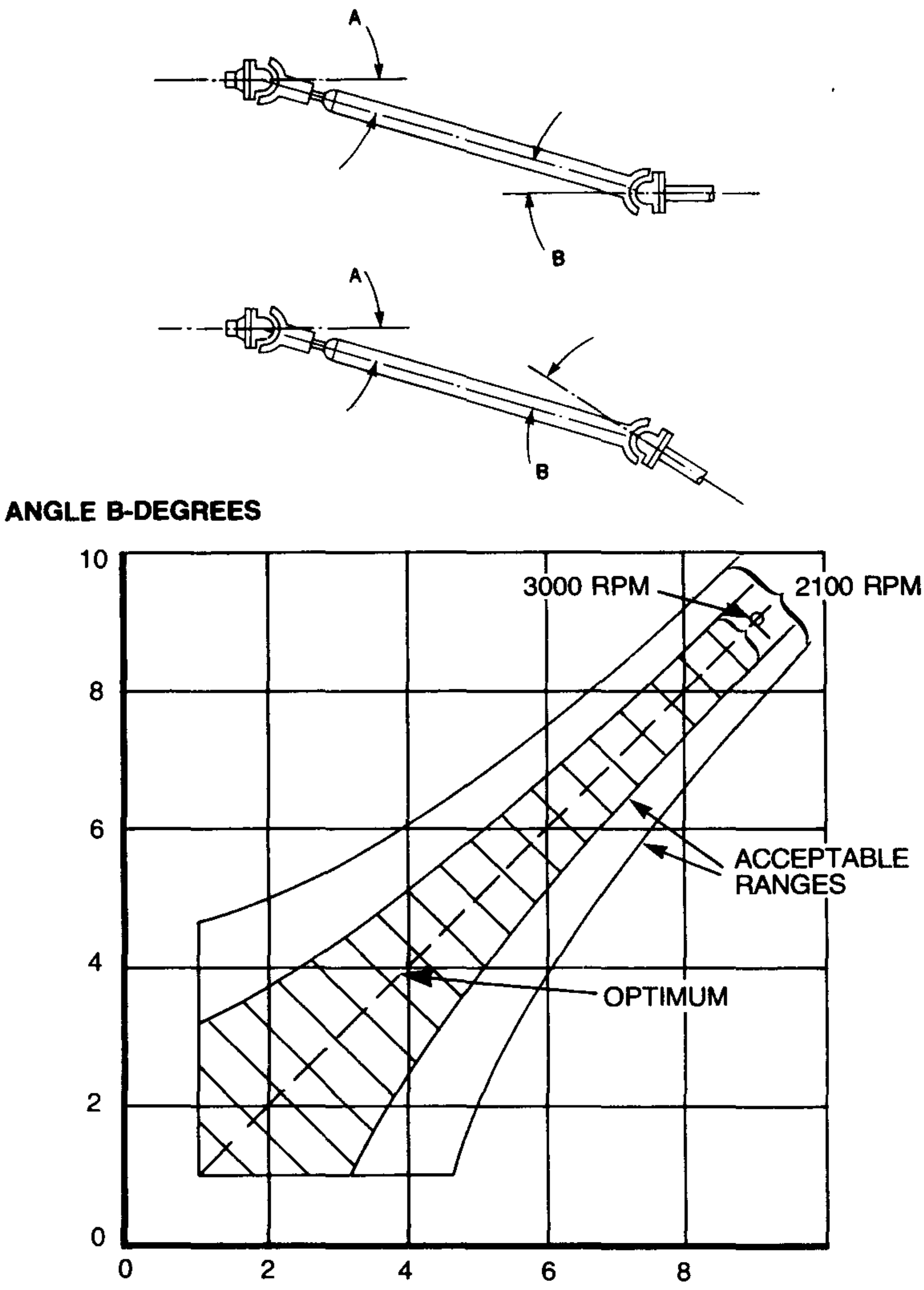


Figure 1.4-5 Acceptable angles for two-joint drivelines without offset

1.4.2.3 Secondary Couple Excitation. This excitation is caused by the Cardan joints transmitting torque at an angle. The secondary couples react about the shaft's supporting members and are equivalent to a static force plus an oscillating force with a frequency of two cycles per revolution. The magnitude of the excitation depends on the transmitted torque, joint angle size, support bearing spans, and phase relationships of the joint yokes.

The secondary couple forces will excite the support bearing at a shaft rotating speed equivalent to one-half of the resonant frequency due to the fact that the oscillating force occurs twice per revolution of the shaft. Experience with vehicle driveline installations using shaft support bearings has shown that the dynamic or rotating couple force should be minimized to prevent an objectionable shudder vibration. Experience has provided the following guidelines to minimize the effects of secondary couples:

Parallel Shafts. The maximum joint angle for a propeller shaft length over 1016 mm (40 in.) should be eight degrees centerline-to-centerline. For shorter propeller shafts, the maximum angle can be determined by using the factor L/5, where L is the propeller shaft length centerline-to-centerline in inches.

Intersecting Shafts. Joint angles must be smaller because of less favorable summation of forces producing the couples. The joint angles of continuous running drivelines for these installations should be less than L/10.

NOTE: Where drivelines involve three or more joints with unequal angles and offset, the analysis becomes complicated and the solution cannot be graphically represented. Therefore, for these complex drivelines, it is recommended that the driveline manufacturer be consulted or that the Data Sheets provided at the end of this section be completed and sent to DDA Transmission Application Engineering for computer analysis.

Throughout this discussion it is assumed that the yokes on a given propshaft are always aligned. It is good practice to design drivelines to within the accepted limits without 'misindexing' the yokes. This avoids service problems in the field associated with improper alignment of the yokes after disassembly.

1.4.3 Input-driveline Angles

Always keep input driveline angles to a minimum due to the torsional activity created. Furthermore, tighter restrictions must be used on input drivelines than on output drivelines due to the nature of mass elastic systems that input drivelines represent and due to the additional factors discussed in Section 1.5 TORSIONAL EXCITATION. Experience with remote-mounted transmissions has shown that input driveline angles should never exceed four degrees and should fall within the limits imposed by the curve shown in Figure 1.4-4, Allowable angles for input and output drivelines as related to maximum shaft speeds.

Input drivelines should always be designed as shown in Figure 1.4-2, Examples of complete cancellation of fluctuating motion. Should input torsional vibrations become a problem, the use of engine flywheel dampers or a torqmatic coupling provides sufficient dampening.

1.4.4 Output-driveline Angles

The use of a two-joint output driveline, similar to the input driveline, is common in vehicle drivetrains. However, different parameters govern the design of two-joint output drivelines. Refer to Figure 1.4-5, Acceptable angles for two-joint drivelines without offset, to determine the maximum angle that yields acceptable levels of angular acceleration. Output drivelines have the additional problem of being affected by axle travel in two different areas as discussed in Section 1.4.8 Axle Travel.

1.4.5 Indexing

Normally, the universal joint at each end of a propeller shaft should be indexed so that the yokes are in the same plane. Misindexing may cause torsional and noise problems. However, there are instances where a slight degree of misindexing is necessary to correct other torsional or noise problems. When this is contemplated, consult the driveline manufacturer and DDA Transmission Applications Engineering.

1.4.6 Balancing

Driveline balance is controlled by the driveline manufacturer. Provide the manufacturer with the maximum driveline operating speed for balancing the shafts at that speed. Most manufacturers balance heavy-duty drivelines between .4 and 1.0 ounce-inch for each 10 pounds of weight divided proportionally at each end. The weight is based on the complete shaft assembly, less flanges and end yokes.

In conjunction with the balancing, it is important to realize that the shaft assemblies should be as straight as possible. It cannot be over-emphasized that the optimum operation of a power train depends upon the capability of the manufacturer to provide straight, balanced drivelines.

1.4.7 Slip Joints

In order to absorb axial travel that may result from power package and/or axle movements, slip joints are required in the driveline. When friction coefficients in the slip joints are not minimized, thrust loads that vary directly with the output torque may result in adverse effects on transmission output components. Values of thrust that can be expected from slip joints with acceptable coefficients of friction are shown in Table 1.4-1.

The location of the slip joint is also important. As slip joints loosen with wear and can cause out-of-balance conditions which impart cyclical loads on the driveline supports, locate slip joints close to the axle or transfer case to take advantage of the relatively large support bearings at these locations.

Table 1.4-1 Thrust load of driveline slip joints

Spline Size	Spline Number	Average Spline Contact Radius (μ = .15)		Slip Resistance of U-joint: Static Torque (μ = .11)		Slip Resistance of U-joint: Dynamic Torque	
O.D.	Teeth	mm	in.	kg/N·m	lb/lb-ft	kg/N·m	lb/lb-ft
2.375	16	27.94	1.10	.55	1.63	.40	1.19
2.625	16	30.99	1.22	.49	1.47	.37	1.09
3.000	16	35.56	1.40	.43	1.29	.32	.95
4.883	29	61.47	2.42	.25	.74	.18	.54
5.500	33	69.85	2.75	.22	.66	.16	.48
7.833	46	99.57	3.92	.16	.47	.11	.34
8.667	52	109.98	4.33	.14	.41	.10	.30
11.000	30	135.38	5.30	.11	.34	.08	.25

1.4.8 Axle Travel

Axle travel also affects driveline angles and parallelism of flanges as the axle rotates through an arc between a maximum and minimum position. Experience indicates that vehicles with suspensions require flanges set parallel in the nominal axle position. The nominal axle position is defined as the average between empty and fully-loaded conditions.

To establish acceptable driveline angle variations from the nominal angular position, refer to Figure 1.4-5, Acceptable angles for two-joint drivelines without offset, and use the area on the chart bounded by the curve representing the maximum speed of the shaft. Interpolate as required.

Where some offset cannot be avoided, the analysis is complex, however DDA Transmission Applications Engineering will perform the necessary calculations from information provided on the Data Sheet. Refer to sample form at end of this section.

1.4.9 Three-joint Driveline

Some installations require a three-joint driveline. Figure 1.4-6 Torsional acceleration and Figure 1.4-7 Inertial acceleration provide acceptable angular limits when the driveline is installed without offset. Use the data sheet to send required information to DDA Transmission Applications Engineering for three-joint or four-joint drivelines involving offset.

The data sheets provided in this section are shown in the following figures:

Two-joint Driveline in Figure 1.4-8
Three-joint Driveline in Figure 1.4-9
Four-joint Driveline in Figure 1.4-10

Procedure for Installation of Three-joint Driveline

With yoke lugs aligned as shown:

1. Locate joint angle "A" and "C" on chart and connect with straight line.
2. Intersection of line is ideal joint angle "B".
3. Maximum deviation from ideal angle "B" is ± three increments on the variation scale "b" corresponding to the engine NO LOAD governed speed.
4. Verify that 'A' and 'C' falls within the shaded area for the angle 'B' selected using Figure 1.4-7.

NOTE: Three-joint system design must satisfy both Figure 1.4-6 and Figure 1.4-7.

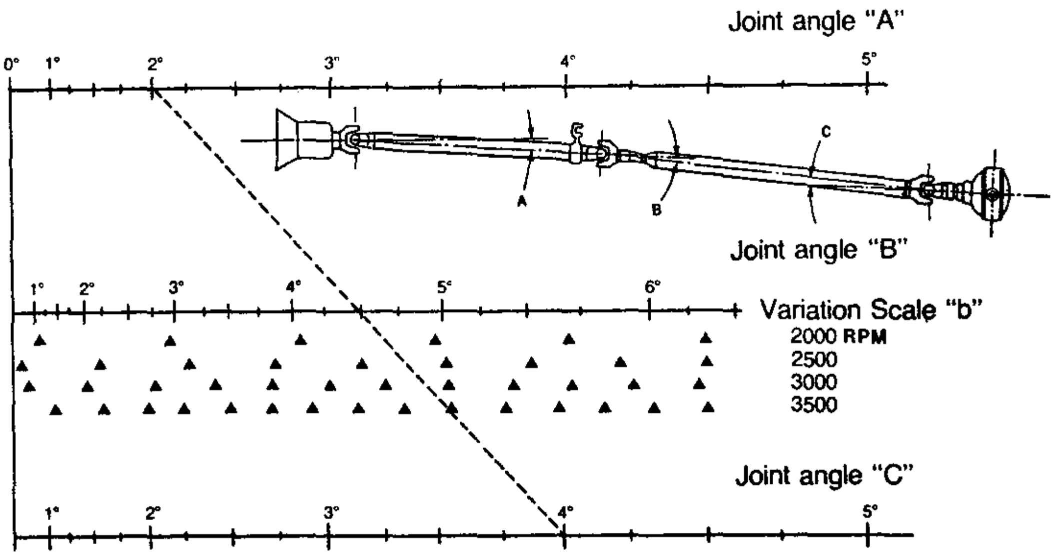


Figure 1.4-6 Acceptable angles for a three-joint driveline considering torsional acceleration

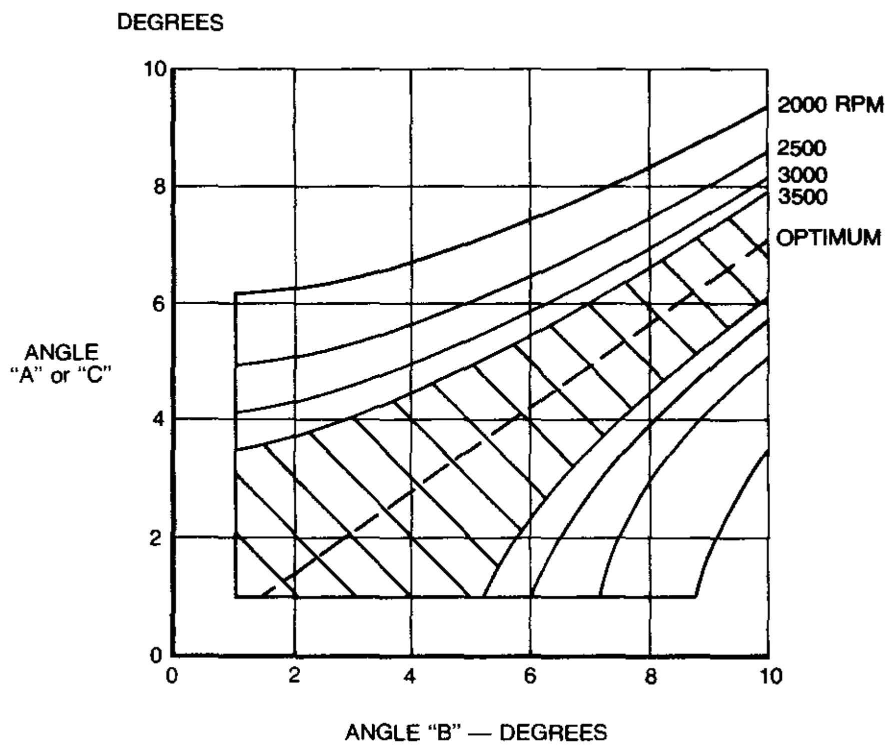


Figure 1.4-7 Acceptable angles for a three-joint driveline considering inertial acceleration

Data Sheet for Two-joint Driveline

Vehicle Manufacturer ______________________ Vehicle Serial No. ______________

Transmission Model ______________ Assembly No. ______________ Serial No. ______________

Engine Manufacturer ______________________ Model No. ____________ Gov. Speed ____________

Driveshaft Circumference ______________________ Joint Index ______________________

Submitted by: ______________________ Company ______________________

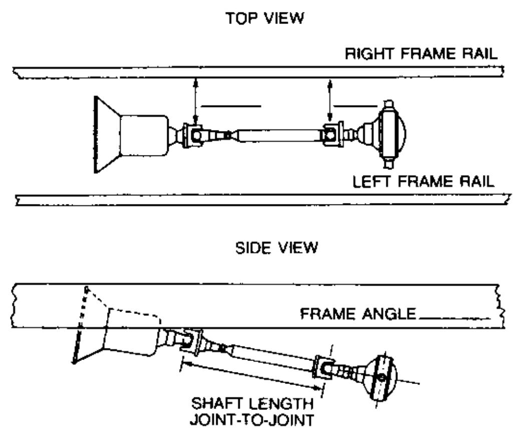


Figure 1.4-8 Data Sheet for two-joint driveline

Data Sheet for Three-joint Driveline

Vehicle Manufacturer ______________________ Vehicle Serial No. ______________

Transmission Model ______________ Assembly No. ______________ Serial No. ______________

Engine Manufacturer ______________________ Model No. ____________ Gov. Speed ____________

Driveshaft Circumference ______________________ Joint Index ______________________

Submitted by: ______________________ Company ______________________

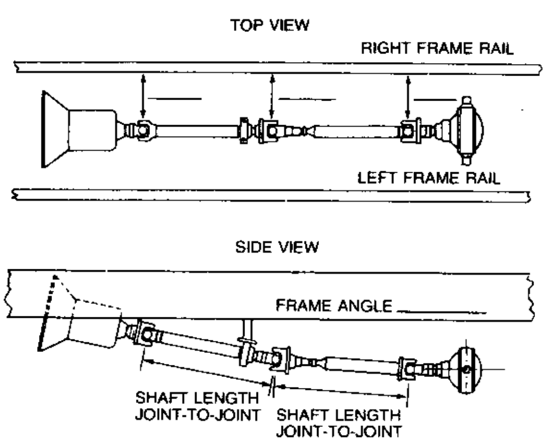


Figure 1.4-9 Data sheet for three-joint driveline

Data Sheet for Four-joint Driveline

Vehicle Manufacturer ______________________ Vehicle Serial No. ______________

Transmission Model ______________ Assembly No. ______________ Serial No. ______________

Engine Manufacturer ______________________ Model No. ____________ Gov. Speed ____________

Driveshaft Circumference ______________________ Joint Index ______________________

Submitted by: ______________________ Company ______________________

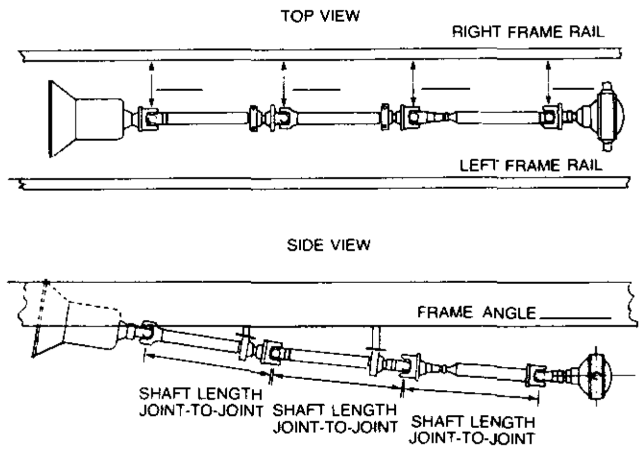


Figure 1.4-10 Data sheet for four-joint driveline

1.5 TORSIONAL VIBRATION

The transmission can receive torsional excitation from the engine and the output drivelines. Experience indicates that uncontrolled torsionals can cause considerable damage to the transmission and driveline components.

Prevention of critical torsional vibrations in the design of the drivetrain system greatly increases the transmission durability. Damage to the drivetrain components occurs during operation when the natural frequency of the drivetrain is at or near the frequency of a vibration-producing element. The condition called resonance exists in a system when the forcing frequency corresponds to a natural frequency.

1.5.1 Transmission Input Torsionals

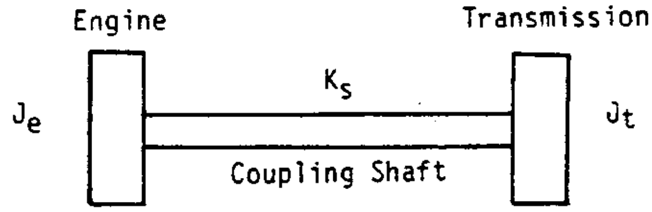
The transmission may be subjected to torsional vibrations which are usually induced by:

- varying engine torques or power pulses causing cyclic vibrations
- excessive driveline angles at the U-joints causing nonuniform motion of the powertrain
- misalignment or misindexing U-joints or flanges causing nonuniform motion of the powertrain.

The last two items were discussed earlier in Section 1.4 DRIVELINES. The cyclic vibrations produced by the engine is the most common source of torsional excitation. When the transmission is mounted remote from the engine, the relatively low spring rate of the input driveline can cause a low frequency resonance to be induced into the transmission. To determine this effect on the transmission, a torsional frequency analysis, as shown below, can be performed to establish the approximate resonant frequency.

The transmission can receive torsional excitation to the input from the power source and input driveshafts. The drivelines, drive trains, tires and suspension can create torsional excitations to the transmission output.

Analysis. The power from a gasoline or diesel engine is delivered not as a steady flow, but as impulses from each cylinder. These torque impulses transmit to the transmission through the input driveline. The engine and transmission can be represented as an equivalent mass-elastic system as follows:



K_s = Coupling shaft stiffness, N·m/rad (in-lb/rad)

J_e = Engine polar moment of inertia, kg·m² (in-lb-sec²)

J_t = Transmission polar moment of inertia, kg·m² (in-lb-sec²)

The pulsating engine torque transmitted through the coupling shaft will have a frequency which may be expressed by the formula:

$$F_f = \frac{N \times P \times S}{60}$$

F_f = Firing frequency (cycles/second)

N = Engine Speed (rpm)

P = Number of cylinders

S = 1 for two-cycle engine, 1/2 for four-cycle engine

To determine the natural frequency (F_n) of the mass-elastic system, the following relationship would apply:

$$F_n = \frac{1}{2\pi} \sqrt{\frac{K_s (J_e + J_t)}{J_e \times J_t}}$$

This is the frequency of oscillation which would be obtained if one end of the system were twisted and suddenly released.

Quite often in this type of system, a condition of operation exists for which the torque (firing) frequency is equal to the natural frequency. This condition, called resonance, creates large cyclic torque amplitudes that do no work, but result in high stresses in the system. Obviously, resonance should be avoided if at all possible.

For an input torsional study, refer to Figure 1.5-1 Data form for torsional vibration study, Table 1.5-1 Input inertias for cycling transmissions, and Table 1.5-2 TORQMATIC ® coupling stiffness. Final approval of the torsional compatibility must be correlated with the engine manufacturer and DDA Transmission Engineering Applications.

The most common method of preventing input torsional problems is to install a torsional damper between the engine and transmission. Most engine manufacturers offer spring dampers with rear enclosures for remote-mount applications. In addition, a viscous damper may be required for torsionally active systems.

Table 1.5-1 Input inertias for cycling transmissions

	Direct Mount		Remote Mount	
Model	**kg·m²**	**lb-ft-sec²**	**kg·m²**	**lb-ft-sec²**
TT 2200	.347	.256	.314	.232
TT 2400	.374	.276	.342	.252
TT 3000	.485	.358	.355	.262
TT 4000:				
TT 400 converter	.485	.358	.355	.262
TT 600 converter	.526	.388	.536	.396
CRT 5633	3.223	2.379	1.321	.975
CRT 5643	.961	.709		

Table 1.5-2 TORQMATIC ® coupling stiffness

Model	Flange Size	Rate	
		N·m/rad	(in-lb/rad)
TT 2000	M5C	3932 ± 407	34,800 ± 3600
TT 2000	M6C	3932 ± 407	34,800 ± 3600
TT 3000	M7C	5288 ± 542	46,800 ± 4800
TT 4721	M7C	5288 ± 542	46,800 ± 4800
TRT 4821	M7C	8814 ± 542	78,000 ± 4800

1.5.2 Transmission Output Torsionals

Many vehicle manufacturers now instrument the pilot vehicle to check for torsional compatibility under actual operating conditions, since output torsionals caused by wheel bounce or hop are usually difficult to predict. Pilot vehicle testing reveals the torsional problems to be corrected before production vehicles are built.

It is possible, however, to estimate the natural frequency of the output driveline system when the following information is provided:

- inertia and stiffness of all components from transmission output to vehicle wheels. When these values are unknown, they may be calculated from prints of the parts involved.
- drawing of vehicle layout
- gross vehicle weight, loaded and empty
- transfer, axle and final drive ratios
- tire size and rolling radius
- vehicle work cycle

With this calculated information and the data gathered from actual operating conditions, the torsional characteristics of the output driveline can be analyzed.

Analysis. DDA Transmission Applications Engineering performs torsional analyses of output drivelines or complete power train designs. Requests submitted for analysis must include all relevant information as outlined on the sample form, Figure 1.5-1, at the end of this section.

REQUIRED DATA FOR TORSIONAL VIBRATION STUDY

ENGINE DATA

General

Engine manufacturer: ______________________ Model No. ______________________

Number of cylinders: __________; Inline __________, 'V' __________, V-angle __________

Four-cycle __________, Two-cycle __________; Gasoline __________, Diesel __________

Firing order: ______________________

Idle speed, (minimum): __________ rpm); Governed speed, (maximum): __________ rpm)

Bore diameter: __________ mm (__________ in.); Length of stroke: __________ mm (__________ in.)

Maximum cylinder pressure: __________ kPa (__________ psi)

Cylinder arrangement and numbering:

Crank arrangement or firing interval:
Attach: Brake power vs rpm curve (from idle speed to governed speed)
Attach: Friction power vs rpm curve (from idle speed to governed speed)

Torsional

Attach: Mass-elastic system: Inertias, kg·m^2 (in-lb-sec^2)
Stiffnesses, MN·m/rad. (in-lb/rad)

Flywheel inertia: __________ kg·m^2 (__________ in-lb-sec^2)

Front accessory inertias: __________ kg·m^2 (__________ in-lb-sec^2)

Reciprocating weight per cylinder: __________ kg (__________ lb)

Harmonic coefficients of tangential effort vs indicated mean effective pressure:

Flywheel damper characteristics: (manufactured, model, type, rate capacity, friction torque)

Engine Front Damper Characteristics: (manufacturer, model, type, rate inertia, viscous damping coefficient)

Figure 1.5-1 Data form for torsional vibration study

(Form continued on reverse side)
(Form Revision 7-81)

REQUIRED DATA FOR TORSIONAL VIBRATION STUDY

DRIVELINE AND VEHICLE DATA

General

Vehicle manufacturer: ______________________ Model designation: ______________

Attach: Vehicle-driveline mass-elastic system:
Inertias, kg·m² (in-lb-sec²)
Stiffnesses, MN·m/rad (in-lb/rad)

or: Layout, assembly and detail prints of driveline and vehicle (axle, wheels, driveshafts, etc.)

Transfer, axle, and final drive ratios: ______________________

Tire size: ______________________, Rolling radius: ______________________

Transmission installation is direct-engine mount ______________, remote mount ______________

Torsional

Attach for each component:
Inertias, kg·m² (in-lb-sec²)
Stiffnesses, MN·m/rad (in-lb/rad)

Couplings

When rubber couplings or similar vibration dampers are installed in the system, include stiffness in M·N·m/rad (in-lb/rad), maximum rated torque in N·m (in-lb), durometer of rubber and its damping characteristics.

All information is required for Torsional Vibration Study.

Mail to: Detroit Diesel Allison GM
Transmission Applications Engineering, K5
P. O. Box 894
Indianapolis, IN 46206

2. TRANSMISSION CONTROL SYSTEMS

To insure proper operation, performance, and overall durability of the cycling transmissions, the control systems must be well designed, properly constructed, and correctly adjusted. The control systems required for the various cycling transmission features are discussed in this section.

All Twin Turbine (TT, TRT, TTB) models require a control system for:

- Range Selection

Additional control systems will be needed for the following options depending upon the specific Twin Turbine model selected:

- Inching Modulation
- Clutch Cutoff Actuation
- Parking Brake Provisions
- Integral Service Brake Application
- Front Output Disconnect

The CRT 5000 transmissions require control systems for both:

- Directional Selection
- Range Selection

Additional control systems will be needed for installations with the following options:

- Clutch-cutoff Actuation
- Parking Brake Application

MODEL SERIES:	T(R)T 2000	T(R)T 3000	T(R)T 4000	CRT 5000
	TT 2000-1	TT 3000-1	TT 4720-1	CRT 5633 LOADER
	TRT 2000-1	TRT 3000-1	TRT 4820-1	CRT 5633 NONLOADER
	TRT 2000-3			CRT 5633-7 w/o DROPBOX
	TRT 2010-3			CRT 5643-2
	TTB 2000-1			

The following subtopics apply to all Allison cycling transmissions, unless otherwise noted:

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2. TRANSMISSION CONTROL SYSTEMS

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2.1 DIRECTIONAL AND RANGE SELECTOR CONTROLS

Several basic systems of selector control may be used with the cycling transmissions. Refer to the Installation Drawings for the various transmission models which are listed on the next page of this manual. Typical systems for manipulating the selector valves (spools) are listed below:

Mechanical-linkage Systems

- Rod and Bell Crank Linkage
- Flexible Cable

Air-actuated Systems

- Multiple-position Relay Cylinder
- Multiple Cylinders
- Impulse Cylinder

Hydraulic System

- Multiple-position Relay Cylinder
- Multiple Cylinders
- Impulse Cylinder

Any of these control systems should be designed and adjusted to allow the transmission to freely locate the selector valve or valves in the proper spring-loaded detent position. Systems which restrict the valve travel to a nondetented position may reduce clutch life.

2.1.1 Mechanical-linkage Systems

The shift control tower and lever should be mounted and the flexible cable or solid linkage should be installed so that relative movement of the power package does not induce inadvertent movement of the selector valve or lever. This is accomplished by mounting the shift tower on a cross member of the frame or directly on the transmission where possible.

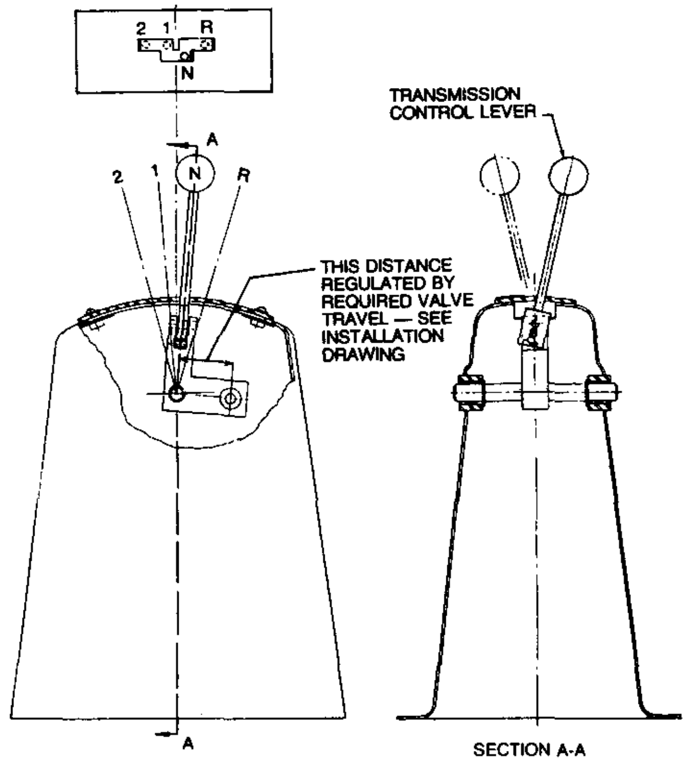
The steering column-mounted shifter, used in typical loader and fork truck applications, requires basic linkage allowance for some movement in the power pack without induced movement in the range selector valve.

In addition to the above constraints, the shift tower and lever should be rigidly mounted to provide a positive, firm feel of the detent of the transmission shift valve or lever. Gating of the shift quadrant should be designed to facilitate selection of the proper position and to minimize the possibility of making an inadvertent shift. To allow the transmission shift valve detent to position properly, the shift quadrant gating should include provision for 10 to 15 percent overtravel at each selected position. Both the selector gating plate and lever should be case hardened for minimum wear. Typical gating patterns of selector controls for cycling transmissions are shown on Installation Drawing AS00-026.

Review the appropriate basic transmission installation drawing from the following list for requirements of apply force and travel of selector valves:

Transmission Models	Installation Drawings
TT 2000-1	AS 22-003
TRT 2000-1	AS 22-017
TRT 2000-3	AS 22-016
TRT 2010-3	AS 22-021
TTB 2000-1	AS 22-026
TT 3000-1	AS 32-001
TRT 3000-1	AS 32-008
TT 4721-1	AS 42-015
TRT 4821-1	AS 42-015
CRT 5633 (loader)	AS 56-015
CRT 5633 (nonloader)	AS 56-016
CRT 5633-7 (without dropbox)	AS 56-017
CRT 5643-2	AS 56-024

A typical floor-mounted shift tower is illustrated in Figure 2.1-1.



This drawing shows principles only. Detail design should be in accord with accepted heavy-duty construction for off-highway applications.

Refer to appropriate transmission installation drawing for required shift force and stroke specifications.

The tower design of the vehicle manufacturer should be reviewed with Detroit Diesel Allison Transmission Application Engineering.

Figure 2.1-1 Floor-mounted shift tower

The connection from the shift control tower or steering column shifter to the transmission selector valve or lever can be rod, cable, or a combination of both. A typical range selector using a lever and rod is illustrated in Figure 2.1-2.

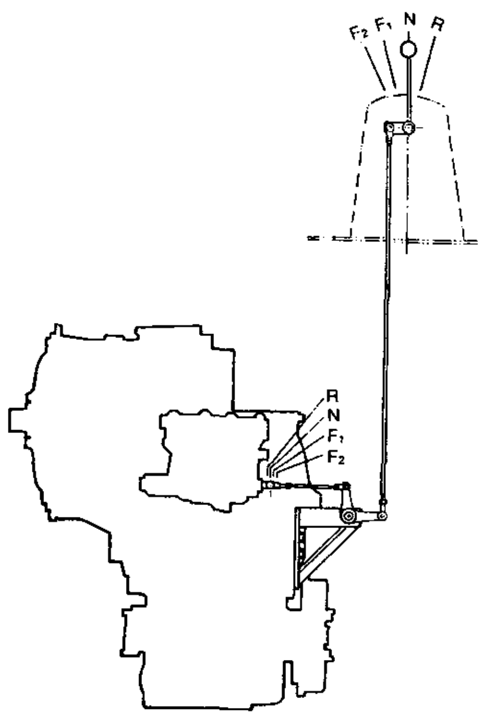


Figure 2.1-2 Lever and rod range control system

2.1.1.1 **Rod and Bell Crank Linkage.** Bell cranks used in the linkage system should be mounted on bushings with provisions for greasing or mounted on sealed antifriction bearings. Joints may be either clevis or ball. The mating lever and pin for clevis joints should be case hardened. Ball joints should include provisions for greasing.

The minimum diameter of rods or tubing used in mechanical linkage should be governed according the the following lengths:

Length (in.)	Minimum Diameter (in.)
Up to 18	.375
18 to 36	.5
36 or more	.625

For lengths over 36 inches, DDA recommends the use of tubing, .75-inch O.D. x .0625-inch wall, to reduce weight and to maintain stiffness. Rods or tubing over 48 inches should be supported every 36 inches. Remember that the installation should not allow transmission motion to induce binding of the linkage or to cause movement of the selector valve.

2.1.1.2 **Flexible Cable.** When flexible cable is used, minimize the number of bends and follow the cable manufacturer's recommendations relative to permissible bend radii. Cables should be of sufficient size to prevent deflection from excessive loading.

Mount cables securely at the transmission and at the shift control tower with adequate support clips in between to prevent excessive backlash in the system.

Route cables to eliminate contact with rotating members or damage from steering mechanisms such as articulation joints. Route cables to prevent contact with high temperature components such as engine exhaust pipes, turbocharger, coolers, and oil reservoirs.

Seal cables properly to prevent dirt contamination and water entry. Figure 2.1-3 diagrams a typical flexible cable installation of a range selector system.

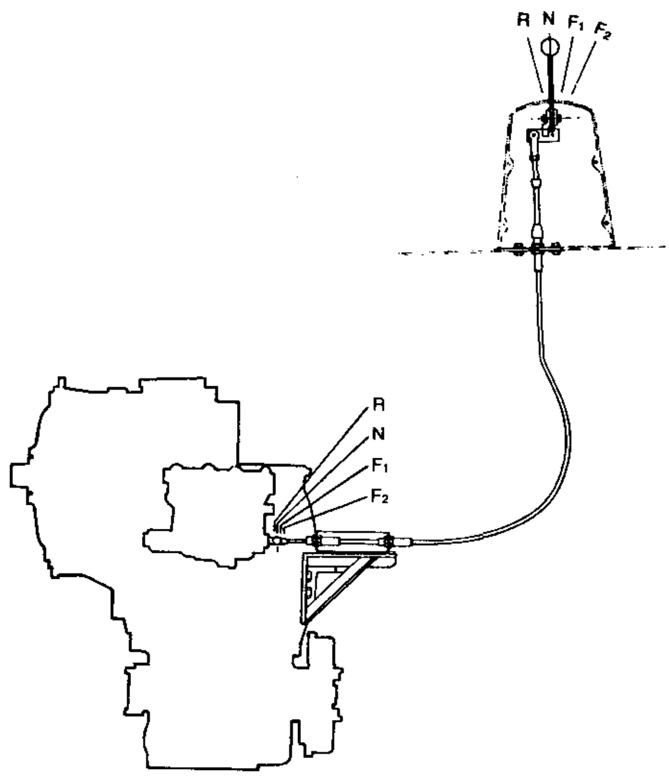


Figure 2.1-3 Cable range control system

2.1.2 Air-actuated Systems

Air-actuated controls are desirable when the vehicle operating controls are located a considerable distance from the transmission. The routing of air lines is relatively easy compared to the installation of stiff linkages and cables.

Three basic air-actuated shifting configurations are commonly used:

- multiple-position relay cylinder,
- multiple cylinders,
- and impulse cylinder arrangements.

2.1.2.1 **Multiple-position Relay Cylinder.** As its name indicates, this cylinder has several control positions. It attaches directly to the transmission selector valve, or via some linkage, and strokes the valve through the range positions.

- The cylinder stroke must be matched to the selector valve stroke.
- Positive stops must be provided in the relay cylinder to prevent excessive forces on the selector valve that can damage the valve body.
- A cab-mounted air valve or an electrical control-to-solenoid air valve may be used to control the relay cylinder.

Figure 2.1-4 illustrates a multiple-position relay cylinder.

Figure 2.1-5 diagrams a typical range selector system using this cylinder.

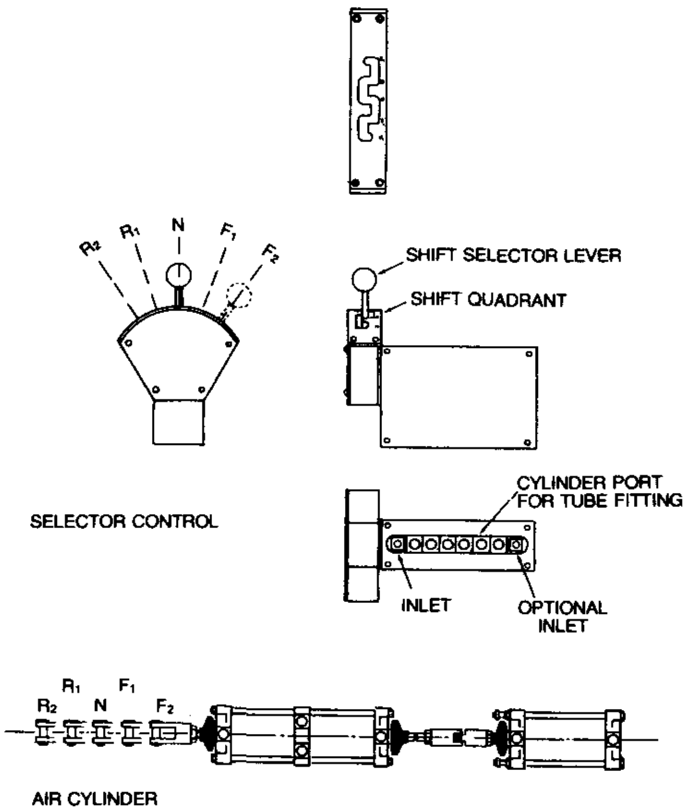


Figure 2.1-4 Multiple-position cylinder range selector

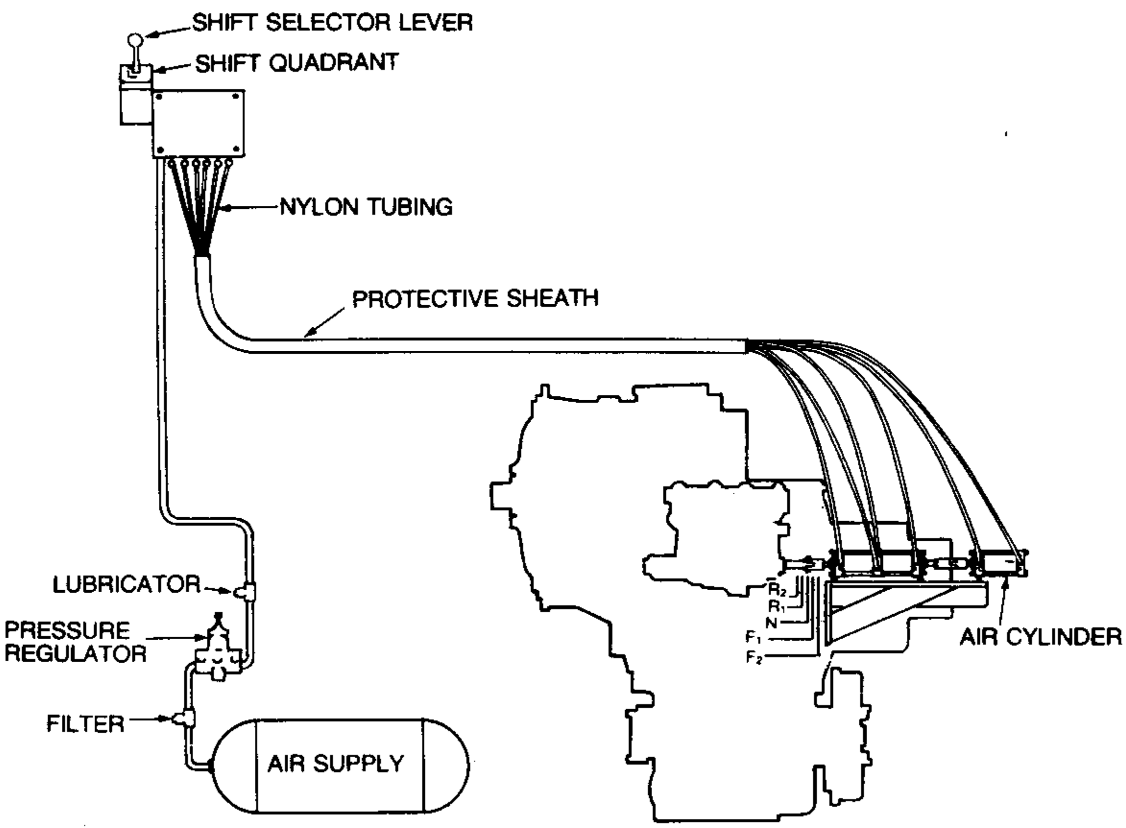


Figure 2.1-5 Multiple-position cylinder range selector system

2.1.2.2 Multiple Cylinders. The use of multiple cylinders with attached bell cranks and pivot points will actuate push-pull selector valves on the cycling transmissions.

- The cylinder strokes and linkage geometry must be matched to the selector valve stroke.
- Positive stops must be provided to prevent excessive forces on the selector valves that can damage the valve body.
- A cab-mounted air valve or an electrical control-to-solenoid air valve may be used to control the multiple cylinders. Details of a typical installation are shown in Figures 2.1-6 and 2.1-7.

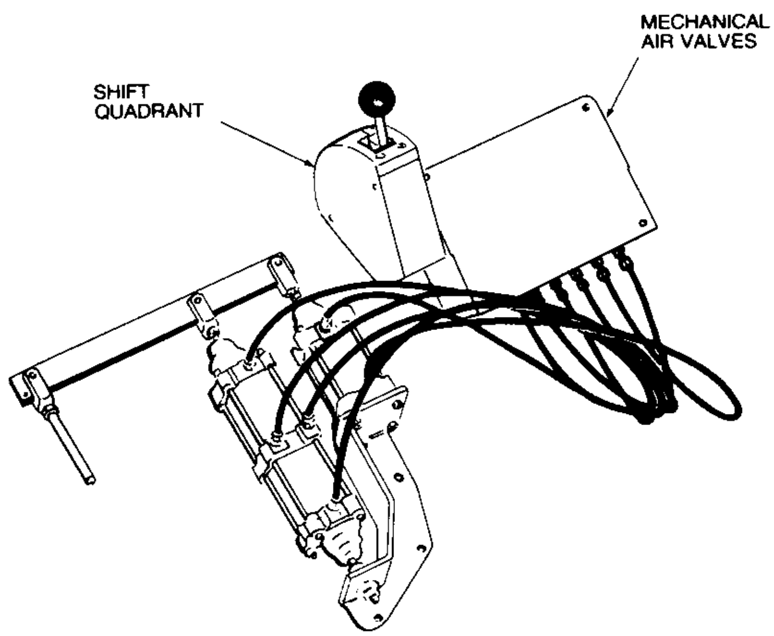


Figure 2.1-6 Multiple-cylinder range selector

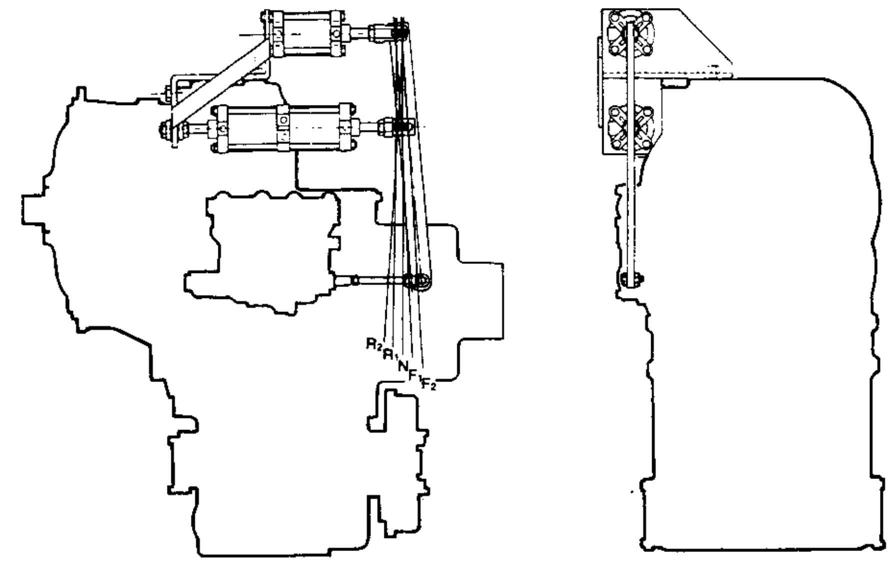


Figure 2.1-7 Multiple-cylinder range selector control

2.1.2.3 **Impulse Cylinder.** An impulse cylinder provides another method of air shifting the gear ranges in the cycling transmission. Figure 2.1-8 shows the installation of this type air shift control for a twin-turbine transmission. The CRT 5633 has both range and directional selector valves. Each selector valve requires a separate selector control lever and impulse cylinder. The operational procedure for this type system with CRT 5633 would be as follows:

- Moving the selector control lever up results in a transmission selector valve shift to forward, while moving the selector control lever down results in the selector valve shift to reverse.
- When the hand releases the selector lever, the centering springs return the control valve lever to a neutral mid-position, from which it can be moved either direction again.
- The air impulse initiated by the hand-controlled selector valve lever actuates the range shifter mechanism on the transmission for a one position up or down shift.
- Range selection lights verify the transmission gear range for the operator. Install the range selection light panel where the operator can easily see it.

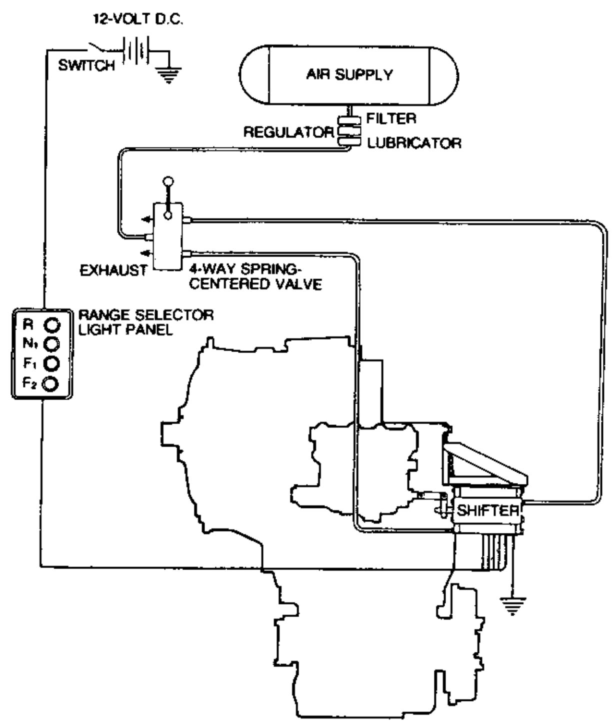


Figure 2.1-8 Impulse-cylinder shift control

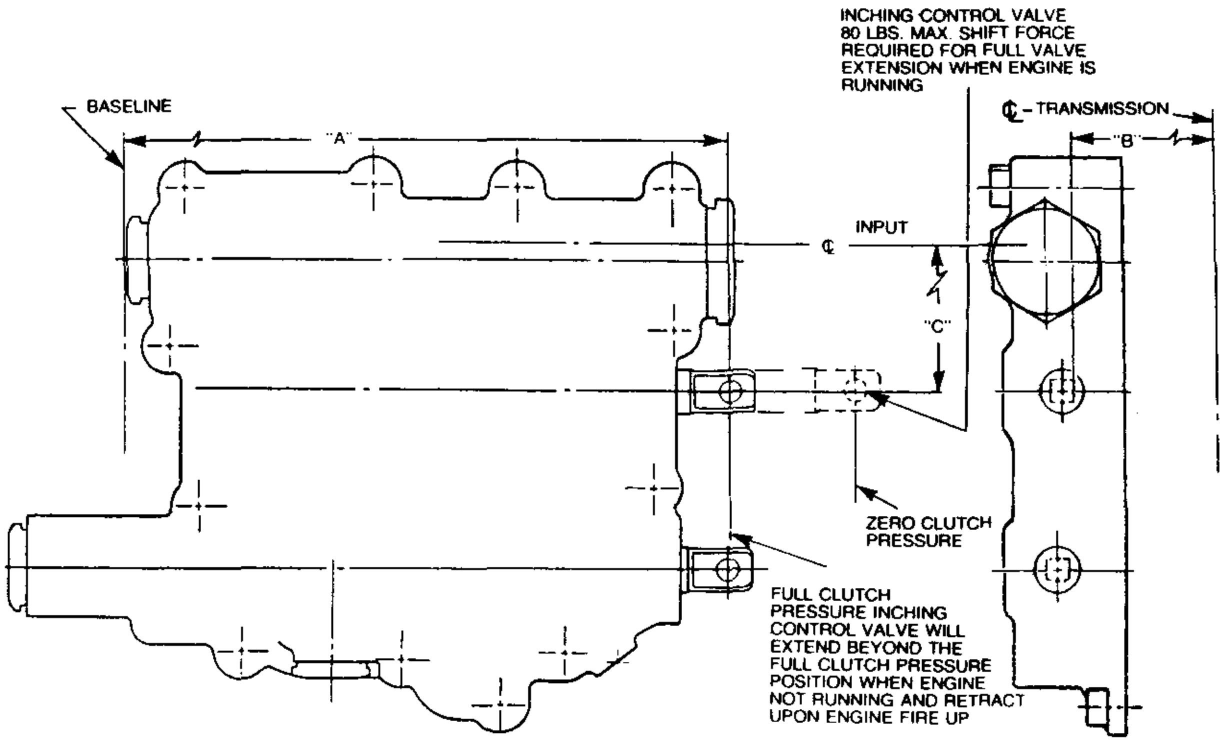
2.1.3 **Hydraulic-shift Controls**

Hydraulic-shift control systems similar in function to the air-actuated controls described above are also available.

2.2 OPTIONAL INCHING MODULATION

The T(R)T 2000, TRT 3000, and T(R)T 4000 series transmissions can be equipped with an optional inching modulation feature. This feature is used predominately with fork-lift trucks and general material-moving applications. These applications require slow maneuvering of the vehicle while the engine is maintained at constant speed for operation of hydraulic equipment. The inching feature allows the transmission clutch to be modulated similar to a mechanical clutch. Controls similar to those shown in Section 2.1 for range selection may be used. Linkage, cable or air systems are typical, with either a foot-pedal or a hand-lever design for operator control of the inching maneuver. Approximately 355 newtons (80 pounds) maximum linear force fully strokes the inching valve control. Valve travel is nominally 510 millimeters (2.02 inches).

Figure 2.2-1 illustrates various details of the inching control of the transmission valve body.



Model Series	Installation Drawing	"A"	"B" Dimensions	"C"
TT 2000	AS 22-003	9.76	9.065	2.40
TRT 2000	AS 22-021	9.76	9.065	2.40
TRT 3000	AS 32-008	9.76	9.065	2.40
TT 4000	AS 42-015	0.35	10.44	4.40
TRT 4000	AS 42-015	0.35	10.44	4.40

Figure 2.2-1 Location of the inching control valve

2.3 OPTIONAL CLUTCH-CUTOFF ACTUATION

Certain applications require the stationary operation of the vehicle at full engine speed to provide maximum pump speed. These applications require the installation of a cutoff to permit internal release of hydraulic clutches without physically shifting the range selector valve to neutral. Depending upon the particular vehicle, hydraulic or pneumatic controls may be installed for this function.

2.3.1 Hydraulic Controls

Install the clutch-cutoff control so that the transmission drive releases when the service brakes are applied. Tap the hydraulic pressure from the service brake system of the vehicle to actuate the clutch-cutoff control.

Consider the three general types of hydraulic brake systems:

- DOUBLE MASTER CYLINDER. First cylinder provides high volume, low pressure; second cylinder provides low volume, high pressure.
- VACUUM BOOST. On gasoline engines the master cylinder actuates a vacuum diaphragm which boosts pressure to the brake cylinders in the wheel.
- MODULATED HYDRAULIC PRESSURE. Brake pedal actuates a valve which modulates pressure to the wheel cylinders.

Connect the clutch-cutoff valve to the various brake systems so that minimal brake pedal effort will not actuate it. This action will prevent clutch release when applying brakes to slow the vehicle speed slightly on grade decents, but still provide clutch release and maximum implement pump speed during a quick stop, high productivity cycle.

Take care that line restrictions are minimized to assure quick system response upon release of the service brakes.

Most commercially available brake fluids are acceptable. However, consult DDA Transmission Engineering if there is any question regarding the compatibility of the service brake fluid with the clutch-cutoff control seal. Brake fluid allowed to contaminate the transmission oil can cause transmission damage.

Specifications for installation of the hydraulic clutch-cutoff valve in the twin-turbine and CRT5000 transmission applications are listed below:

HYDRAULIC CLUTCH CUTOFF SPECIFICATIONS

	Twin Turbine	CRT 5633	CRT 5643
Installation Drawings:	Basic	AS 56-020	(not available)
Thread Size:	.125-27NPTF	.125-27NPTF	.125-27NPTF
Actuation Pressure:			
Minimum	896 kPa	1035 kPa	800 kPa
Optional Minimum	1724 kPa	-----	-----
Maximum	13790 kPa	13790 kPa	13790 kPa
Full-apply Oil Volume:	1.12×10^{-6} mm^3	(not available)	(not available)

2.3.2 **Pneumatic Controls**

Vehicles installed with air brake systems will naturally use pneumatically-actuated clutch-cutoff controls, since the function is identical to that for hydraulic brake systems. Install the connection to release the transmission drive when the service brake is applied. Use an Airmite-type air cylinder to actuate the clutch-cutoff valve in the transmission valve body.

Specifications for installation of a pneumatic clutch-cutoff control valve are listed below:

PNEUMATIC CLUTCH-CUTOFF SPECIFICATIONS

	Twin Turbine	CRT 5633	CRT 5643
Installation Drawings:	AS 00-027	AS 56-019	Basic
Thread Size:	.625-18UNF-2B	.625-18UNF-2B	.625-18UNF-2B
Actuation Force (air cylinder):	111.0 N	156.0 N	120.0 N

2.3.3 **Dual Operation: With and Without Cutoff**

Some vehicle applications will require provisions for operating with and without clutch cutoff. Install a selector valve to route the control lines for either mode by operator choice. The procedure will depend on the various hydraulic or pneumatic systems used for the brakes.

The installation of two brake pedals is another means of accomplishing the dual option. Connect one pedal to control clutch cutoff; the second pedal by-passes the cutoff via check valves.

Installation may be designed to actuate the clutch cutoff when the vehicle parking brake is applied. This prevents inadvertent damage by operating the vehicle with the brake engaged. The type of parking brake system will dictate the feasibility of such clutch-cutoff usage.

2.3.4 **Control Lines**

Carefully select general routing paths of control lines to meet system operating requirements and prevent damage by chaffing from contact with vehicle components.

2.4 PARKING BRAKE PROVISIONS

A parking brake assembly or a provision for one is available with all twin-turbine transmissions. However with the CRT's, only the dual output version of the CRT 5633 offers this option. The most common means of controlling or applying the vehicle parking brake is by air-cylinder or mechanical linkages.

The respective Basic Installation Drawings for the cycling transmissions show details for parking brake options. The parking brake on the transmission is actuated by moving a lever in either direction. Mechanical rod and linkage, cable, or air systems may be installed.

2.4.1 Air-cylinder Control

The spring-applied, air-release cylinder is the most acceptable method of applying the vehicle parking brake. Internal spring forces and air-release cylinder capacity must be matched to the specific installation requirement.

Securely mount the apply cylinder with the apply force exerted at nearly a 90° angle to the brake-lever arm. Usually a solenoid valve is installed to control the release of air to the apply cylinder. As discussed in Section 2.3, some control systems are integrated to engage clutch cutoff when the parking brake is applied. If the integrated system is not installed, a warning light or buzzer should be installed as a means of preventing damage to the brakes and to the transmission which result from operating the vehicle with the brake applied.

A typical air-cylinder brake system is illustrated in Figure 2.4-1.

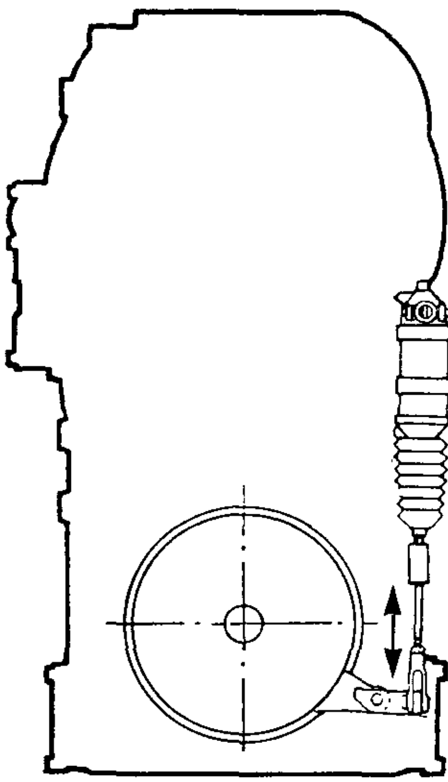


Figure 2.4-1 Air-cylinder parking brake system

2.4.2 Mechanical Linkage

Either solid rod or cable may be used for the mechnical linkage to apply the parking brakes. This system is not recommended for heavy vehicle installations due to applied force requirements. When mechanical linkage is used, refer to DIRECTIONAL AND RANGE SELECTOR CONTROLS Section 2.I.1 **Mechanical-linkage Systems** which outlines the same design considerations to follow adding size for the higher operating forces.

Figure 2.4-2 shows a typical solid-linkage installation and Figure 2.4-3 illustrates a cable system.

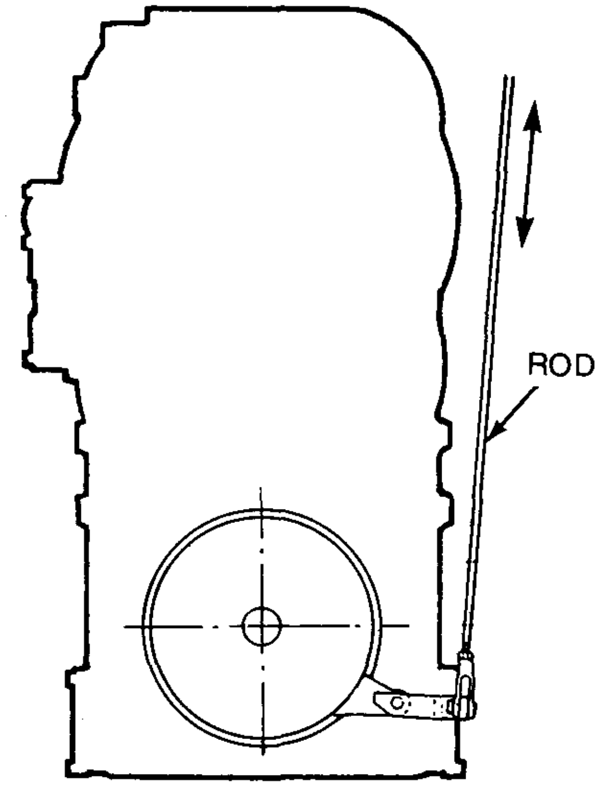


Figure 2.4-2 Solid-linkage parking brake system

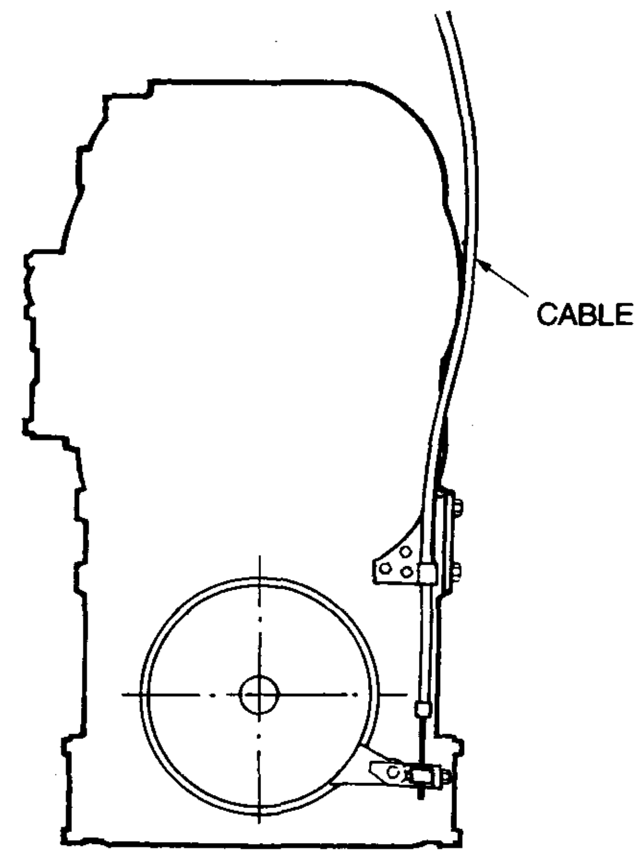


Figure 2.4-3 Cable parking brake system

2.5 **INTEGRAL SERVICE BRAKE**

The TTB 2000-1 transmission incorporates an integral brake which can be used in place of normal service brakes. This feature is particularly valuable in vehicles operating in severely dirty, muddy, or wet environments where normal vehicle brakes are easily contaminated and damaged.

The integral brake is actuated by a hydraulic line connection between the vehicle brake master cylinder and the transmission. Figure 2.5-1 shows a typical installation.

Most commercially available brake fluids are acceptable. However, consult DDA Transmission Engineering Applications if there is any question regarding the compatibility of vehicle service brake fluid with the integral brake seal. Brake fluid allowed to contaminate the transmission oil can cause transmission damage.

The integral brake static capacity and other details relating to its installation are indicated on Installation Drawing AS 22-026.

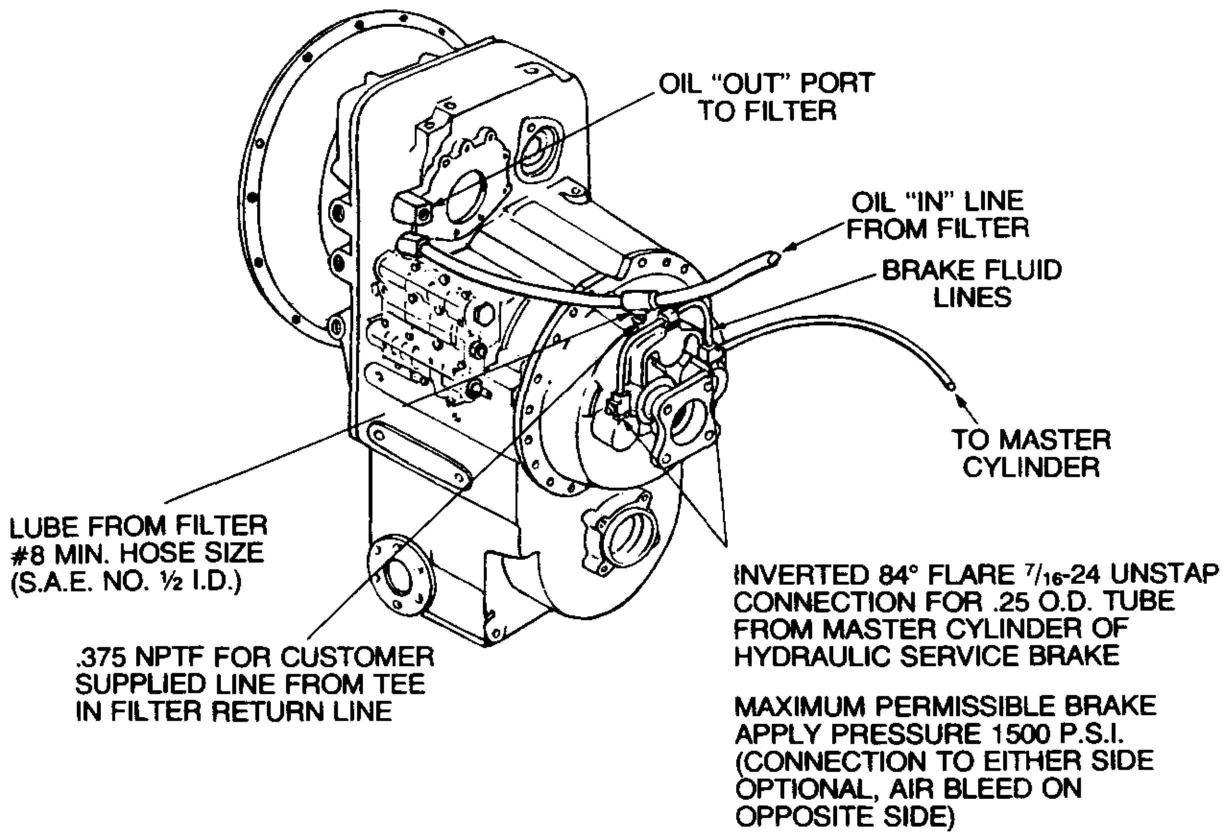


Figure 2.5-1 Integral service brake actuated by master cylinder

2.6 **FRONT-OUTPUT DISCONNECT**

The Twin Turbine transmissions (dropbox models: TT, TRT, TTB) can be supplied with a front-output disconnect for disengagement of transmission front-output shaft. Vehicles using all wheel drive for off-road use and single-axle drive for roading operations are typical applications of this feature.

Either solid bar or cable mechanical linkage is recommended. Usually a hand lever operates the linkage. The mechanical design practices previously discussed in Section 2.1.1 should be followed. Disconnect-lever force requires 490 newtons (110 pounds) linear pull with a linear travel of 43.5 millimeters (1.7 inches).

Internal detents locate the disconnect rod in both the engaged and disengaged positions. Therefore, return springs or position detents are unnecessary on the mechanical linkage.

There are two points of adjustment for the front output disconnect. The transmission shifter shaft must be adjusted first, then the linkage must be adjusted. The shifter shaft is adjusted by pushing it inward (to the rear) to its engaged detent position. The shaft may be rotated to locate the center of the clevis pin hole at 9 mm (.375 in.) ahead of the mounting pad face of the linkage support bracket. When the shaft is pulled out to the disengaged detent position, the center of the clevis pin hole is approximately 54 mm (2.125 in.) ahead of the mounting pad. Adjust the linkage so that the engaged and disengaged positions of the operator's control correspond exactly with the detent position of the shifter shaft.

Basic installation drawing for the twin turbine transmissions illustrate disconnect lever location and details. Figures 2.6-1 and 2.6-2 illustrate typical solid link and cable disconnect systems.

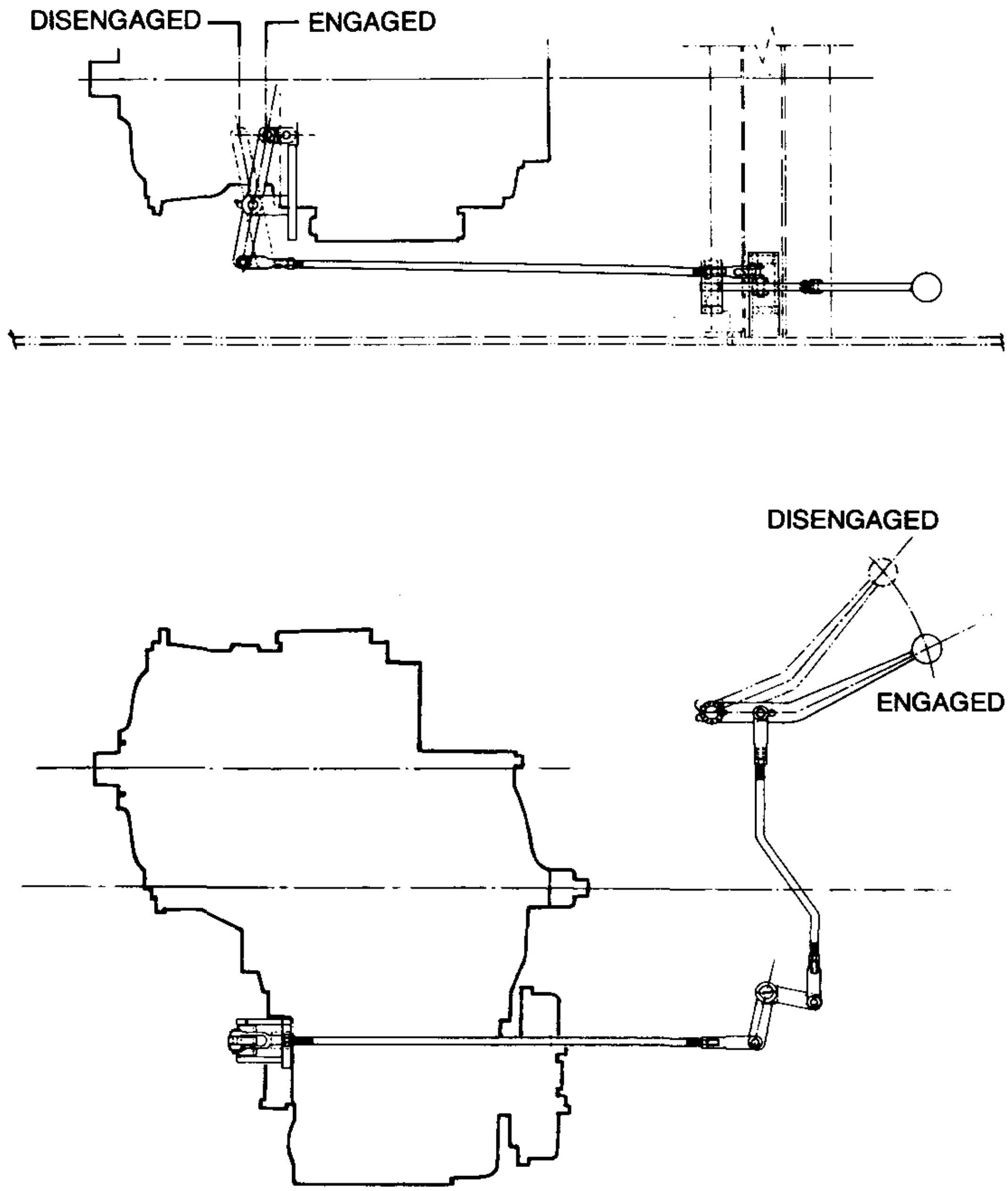


Figure 2.6-1 Solid link output disconnect of clutch control system (TT 2000-1)

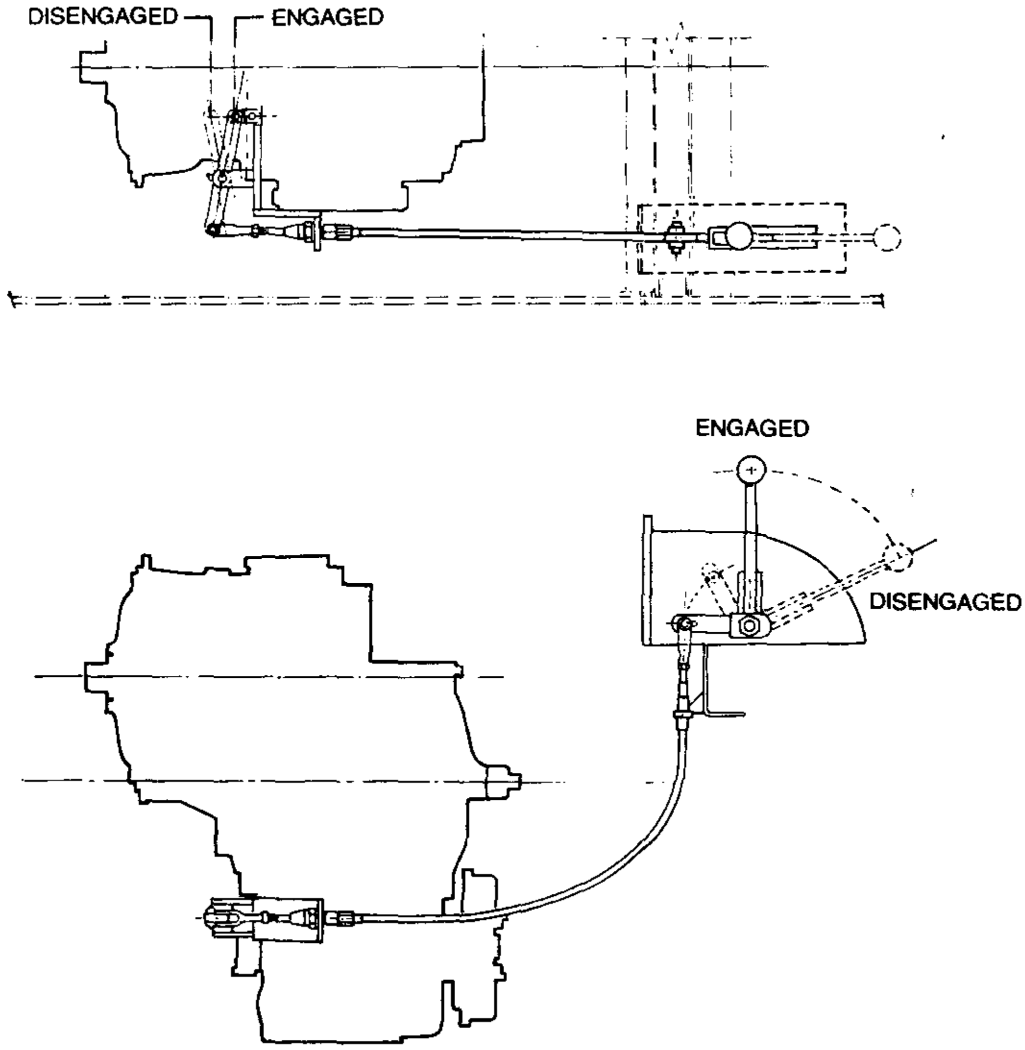


Figure 2.6-2 Cable disconnect of clutch control system (TT 2000-1)

3. TRANSMISSION OIL SYSTEM

All Allison cycling transmissions use a modified series oil system. The oil is drawn from a single source of supply located in the oil sump and is drained back by gravity after serving the following functions:

- actuates transmission controls
- serves as torque transmitting medium in the torque converter
- engages, lubricates, and cools the clutches
- lubricates and cools the transmission components
- serves as the heat transfer medium to the external cooling system
- serves as the medium to transfer suspended contaminants from the transmission oil system to the filters.

Within this system there are two major external circuits for filtration and cooling.

In order to obtain optimum transmission performance and durability, careful attention must be given to the selection of the hydraulic fluid, the filtration of that fluid, the fluid temperature, and the maintenance or replacement schedule for the fluid.

MODEL SERIES: T(R)T 2000, T(R)T 3000, T(R)T 4000, CRT 5000

The following subtopics apply to all Allison cycling transmissions, unless otherwise noted.

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3.1 HYDRAULIC FLUID

It is important that recommendations for oil specifications are followed closely to insure proper transmission and converter operation, performance, and durability.

All oils conforming to the C-3 specification are proper for the cycling transmissions used in off-highway applications. Contact DDA Service Department for the qualification of particular transmission fluid brands and for recommended viscosities.

3.1.1 Transmission Oil Capacity

The oil capacity of each model cycling transmission as shipped from the factory is published in the PRODUCT DESCRIPTIONS of the various models.

At installation, an additional quantity of oil will be required which is dependent on the volume of the external filter and cooling circuits.

3.1.2 Low Temperature Usage

The C-3 hydraulic fluid specification is recommended for all temperatures since it includes several multi-viscosity fluids. However below −34°C (−30°F), an auxiliary preheat is required to raise the temperature in the sump to this minimum limit. Reference: Section 3.4.4.2 **Low Temperature Use.**

3.1.3 Oil Change Interval

The oil change interval of every 500-1000 hours of operation is generally recommended for the cycling transmissions. This is the maximum interval and the proper frequency is dependent upon the operational environment of each transmission. The recommended change interval should be shortened under severe operating conditions of extreme heat or dust. When the fluid shows traces of contamination or the effects of high operating temperature, as indicated by laboratory analysis, the oil should be changed regardless of the hours of operation. For information pertaining to oil change periods, reference the service or maintenance manual supplied with the vehicle.

3.2 FILTRATION SYSTEM

The filtration system must prevent contaminants such as dirt or other foreign material from circulating through the transmission hydraulic system. Close fitting valves and orifices throughout the hydraulic system and, in particular, the control valve body must be protected from contaminants which may cause sticking or restrictions that will result in improper application of clutches and/or insufficient lubrication.

3.2.1 Filter Circuit

The Twin Turbine transmissions and the CRT 5643 require a remote main circuit oil filter supplied by the customer. However, the CRT 5633 is available with either this provision or an integrally-mounted filter assembly which can be purchased with the transmission. This assembly includes two AC PF-151 filter elements in parallel.

The remote filter system for each series of transmission should be designed by the customer according to the specifications and mounting recommendations on the following installation drawings:

Transmission Models	Hydraulic System Installation Drawings
T(R)T 2000	AS 22-004
T(R)T 3000	AS 22-004
T(R)T 4000	AS 22-003
CRT 5633	AS 56-021
CRT 5643	AS 56-026

In addition, a recommended filter assembly for use with the twin turbine transmissions or the CRT 5643 is illustrated with part number and supplier on AS 00-004 Installation Drawing. The recommended base and filter for the remote filter circuit of the CRT 5633 is shown on AS 58-004. A remote filter, when properly installed, offers the advantage of being located where it can be serviced easily.

In general, the filter circuit designed by the customer must prevent contaminants such as dirt and foreign material from circulating through the transmission hydraulic system, be capable of handling transmission oil flow without creating an excessive pressure drop in the circuit, and withstand maximum transmission oil temperature. It is particularly important to keep the number of bends and elbows at a minimum to reduce line loss and pressure drop in the circuit. The filter circuit pressure drop limits are indicated on the above hydraulic circuit installation drawings.

Oil Suction Strainer

An oil strainer, which is on the suction side of the charging pump, is **located in the transmission sump** of all cycling transmissions. This suction screen must be removable after the vehicle installation for periodic cleaning. The basic installation drawing for each transmission model illustrates screen-removal space requirements.

For the CRT 5633 applications in which the customer is supplying the oil reservoir or sump, the recommended oil strainer assembly or it equivalent is illustrated in Figure 3.2-1. The oil strainer, part number 6757382, is available from the Detroit Diesel Allison Service Parts department.

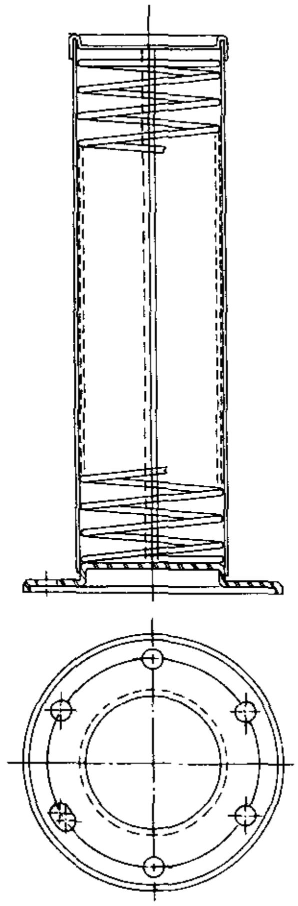

Figure 3.2-1 Oil strainer assembly, Part Number 6757382

3.2.3 Auxiliary Lube Circuit and Filter Requirements

On the loader version of the CRT 5633 transmission, a remote filter is required in the customer-supplied auxiliary lubrication circuit. This filter is on the pressure side of the pump which feeds lube oil to the forward and reverse clutches. The general specifications for this filter and the recommended hose sizes, for connecting to the pump and transmission port, are shown on Installation Drawing AS 56-018.

3.2.4 Breather

The twin turbine transmissions have a self-contained breather near the accessory pump pad on the barrel of the main case. Care should be exercised to avoid plugging this breather with paint, undercoating or any other material.

The CRT 5633 and CRT 5643 breather provision is a 1.25-11.5 NPTF port at the top right side of the dropbox housing as shown on AS 56-015 or AS 56-016 Installation Drawings. The port serves for a customer-supplied breather adaptation. For the CRT 5633, this port also serves as the oil-fill tube provision. A combination breather and fill tube cap, AC part number 1528732 or its equivalent must be supplied by the customer for the CRT 5633. Under extremely dirty or severe operating conditions, a heavy-duty breather is recommended. The AC part number 1553201 is a satisfactory heavy-duty breather.

In general, the breather should provide a passage for normal expansion and contraction of air and fluid within the transmission. Normal operation will result in a mist of oil coming out of the breather. If an excessive amount of oil is found in this area, the problem should be investigated.