

# Product data

## **AUTOMATIC TRANSMISSION FLUIDS**

### **AUTOMATIC TRANSMISSIONS**

An automatic transmission basically composes four main components, as illustrated on the next page:

- the torque converter
- the clutch packs (or clutch pack/brake band assembly)
- the epicyclic gear train
- the hydraulic system

Each component system performs a definite task requiring a lubricant with specific properties to provide smooth, efficient operation of the automatic transmission.

### **TORQUE CONVERTER**

The torque converter has three elements:

- the impeller, connected to the engine
- a turbine member, connected to the gearbox
- a reaction member, or stator.

The working fluid, from the impeller, drives the turbine. The fluid is then returned through the stator to the impeller.

Relative rotational speed between the impeller and the turbine determines the amount of torque multiplication within design limits. This torque multiplication reaches a maximum of about 2:1 with the turbine stationary and falls to 1:1 when the turbine reaches a speed of approximately 90% of the impeller.

When the turbine speed reaches 90% of the impeller speed, the torque converter ceases to multiply the driving torque, becoming a fluid flywheel instead.

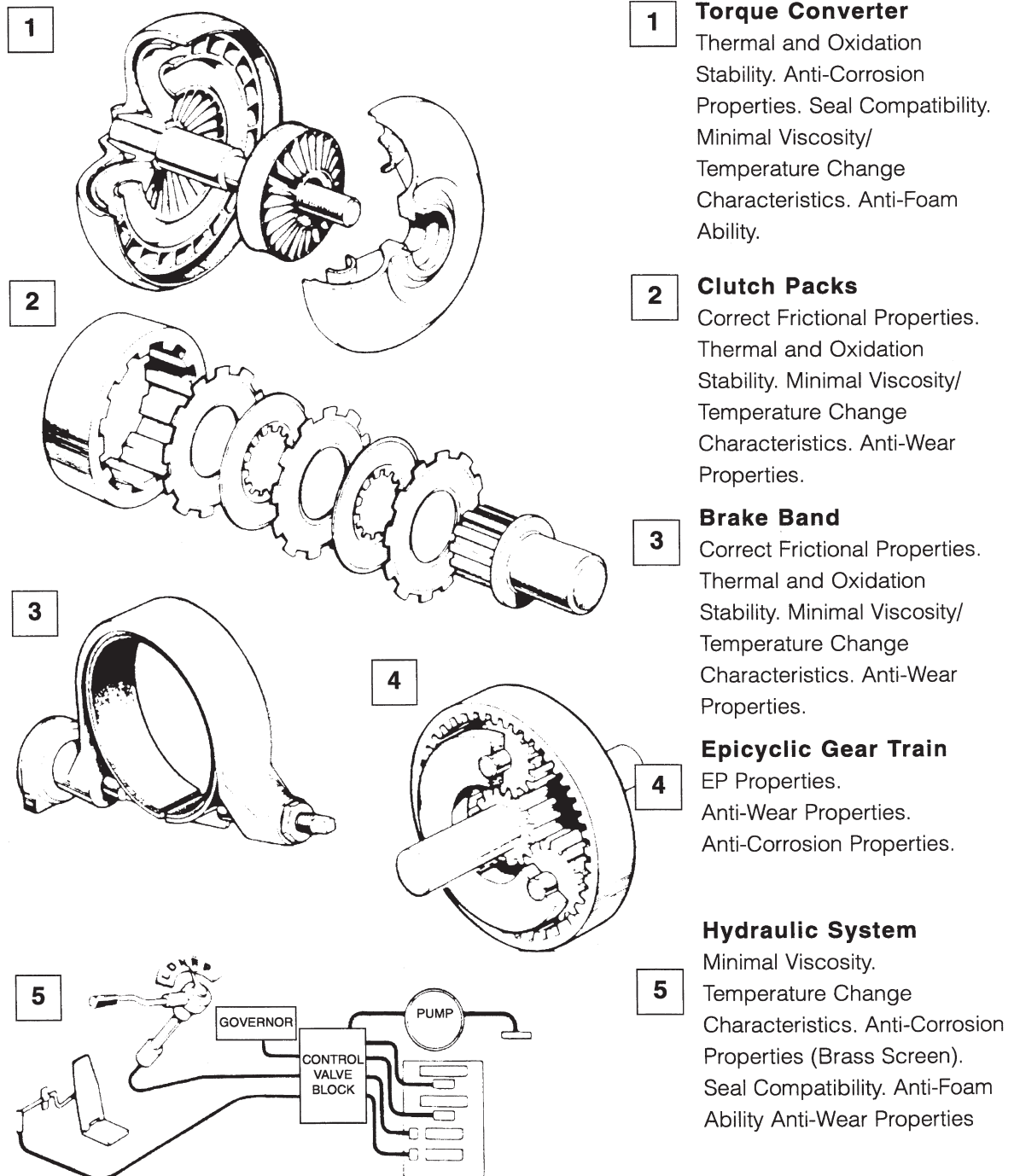
### **CLUTCH ASSEMBLY**

The clutch pack composes of a housing, clutch plates and an internal splined shaft. The housing has internal splines. The clutch plates are a combination of steel and friction material collated alternately. They have either internal or external spline teeth.

When the clutch plates are squeezed together by hydraulic pressure the clutch pack transmits torque. The friction modifying properties of the automatic transmission fluid influence gear change characteristics and torque capacity of the clutch pack and the transmission.

Bands are used to select different gears by allowing different parts of the epicyclic gear to turn, the friction modifying properties of the automatic transmission fluid on the bands also influence the gear change characteristics.

## FLUID REQUIREMENTS



## COMPONENTS OF A TYPICAL AUTOMATIC TRANSMISSION.

Diagrams Courtesy of Lubrizol from Original Paper by A. Towle.

## **EPICYCLIC GEAR TRAIN**

The constant-mesh epicyclic gear train comprises a sun-and-planet assembly encompassed by an annular gear. Power flow through the train can be achieved by holding one gear member and applying drive to another through the hydraulically-operated bands.

## **HYDRAULIC SYSTEM**

To obtain smooth controlled gear changes, a system of valves and servo mechanisms is used to operate the various transmission clutches. Signals indicating road speed and throttle opening are fed into the hydraulic system to give the correct gear ratio for the prevailing conditions.

A number of transmissions now use electronic sensors to measure road speed and throttle setting and use electrically controlled valves to direct hydraulic pressure.

## **AUTOMATIC TRANSMISSION FLUIDS**

An automatic transmission fluid is a very complex lubricant which must function as a -

- power transmission medium
- hydraulic control fluid
- heat transfer medium
- lubricant for all bearing surfaces
- gear lubricant
- lubricant for frictional surfaces
- seal swell agent
- clutch friction control medium over bulk oil temperatures ranging from as low as minus 40°C to as high as 170°C.

Other demands on the fluid require it to resist oxidation and corrosion; operate without foaming; be non-toxic; have a high flash point and acceptable odour.

Operating conditions in automatic transmissions are more severe than in manual transmissions, mainly due to the higher operating temperatures obtained. That means the oil must work over a greater temperature range which demands the use of a stable viscosity index improver. Since the fluid must also serve as a hydraulic control fluid, relatively low viscosity base oils must be used. That makes the base oil/anti-oxidant selection very critical in order to attain satisfactory oxidation stability.

### **ADDITIVES IN AN AUTOMATIC TRANSMISSION FLUID**

To enable an automatic transmission fluid (ATF) to perform the above functions, the following additives are necessary:

- Anti-oxidants - to lengthen fluid life, permit high temperature tolerance and prevent formation of sludge and varnish.
- Detergent/Dispersants - to maintain contaminants in suspension and keep hydraulic control mechanisms and filter screens clean.
- Corrosion Inhibitors - to prevent oil degradation products corroding metal components.
- Anti-Wear Additives - to prevent seizure of metal components under load and provide maximum protection against wear.
- Seal Swell Additives - to provide a controlled amount of seal swell of the rubber compounds; preventing loss of fluid which can lead to overheating and transmission failure.
- Viscosity Index Improvers - used to maintain the correct viscosity characteristics across the operating temperature range.
- Pour Point Depressants - to permit fluid flow at extremely low temperatures.
- Friction Modifiers - to permit smooth gear changes by controlling both the static and dynamic friction coefficients of the clutch surfaces.

NOTE: The Ford M2C-33 F & G specification specifically excludes the addition of friction modifiers.

- Anti-foam - to ensure rapid collapse of foam and rejection of entrained air.

## **SPECIFICATIONS**

There are two basic types of fluids for passenger car automatic transmissions, low static friction (Soft) and high static friction (Hard). There are a range of fluids based on either one of these friction principles and include extra tests considered necessary for the transmission involved. Both of these fluid types originate from the USA, the low static fluid from General Motors and the high static fluid from Ford Motor Company. Virtually all current automatic transmission fluid specifications are of the low static friction type.

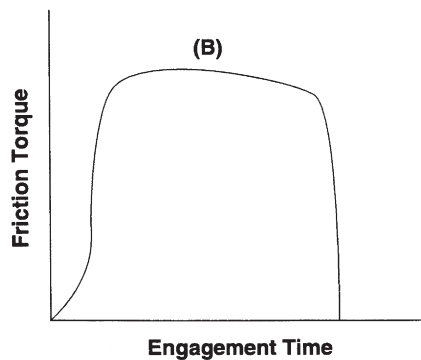
## **DEXRON® LICENSE FLUIDS**

Fluids designed to meet the GM (low static friction) specification are known as “DEXRON®” fluids. “DEXRON®” is a registered trademark owned by General Motors. Companies that wish to market DEXRON® approved fluids must purchase a license number and submit their fluids to testing and continue to produce the fluids without formulation modification to the same quality standard. Formulations may only be changed after retesting and relicensing.

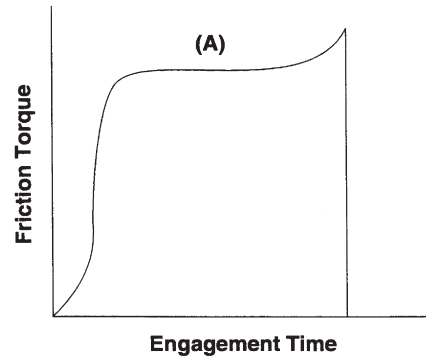
License Approved fluids must display the GM DEXRON® License number on all containers. The latest DEXRON III fluids are known as “F” fluids and include revised viscosity requirements as well as improved oxidation resistance, high temperature performance and friction durability. The license number for **CASTROL TO DEXRON III ‘E’** is F30603.

The new fluid supersedes our previous “E” fluids License Numbers D21885, D21886, D21327. These follow a long history of GM Automatic Transmission Fluids starting in 1949 with TYPE A fluids followed in 1957-8 by TYPE A suffix “A” fluids and DEXRON® “B” fluids in 1968. There were some short lived “C” DEXRON® fluids in 1974-5. In all cases the later fluids supersede the earlier fluids for all GM automatic transmissions back to 1949.

A major difference between Ford M2C-33 and DEXRON® specifications is the friction modifying properties of the fluids on clutch packs and bands.



Low static friction typical of DEXRON® type fluid



High static friction typical of Ford M2033-F&G fluid

NOTE: The friction curves are not drawn to scale.

The coefficient of friction at point (A) on the Ford fluid is up to 50% higher than for a DEXRON® III at point (B).

### **FORD MOTOR COMPANY**

Ford originally developed the M2C-33 specification for automatic transmission fluids back in the early 1960's. These fluids have a high static coefficient of friction. Revisions and upgrades of the specification through to M2C-33G have been incorporated since first introduction through to 1979. The use of the M2C-33G fluid was largely restricted to Ford Europe vehicles 1975-1982 and to Borg-Warner transmissions produced in Europe and some Japanese automatic transmissions.

Since the late 1970's and early 80's Ford USA have changed to low static friction specification fluids, eg M2C-138CJ, M2C-166H and finally M2C-185A, now known as Mercon®. These changes were required due to the adoption of lock-up torque converter clutches and other transmission modifications.

## **FLUID INTERCHANGE**

The later Ford specifications (M2C-13B CJ/166H & Mercon) detailed previously have essentially the same friction characteristics as DEXRON® type fluids, therefore one fluid can satisfy and be approved against both specifications.

The same is not true for Ford M2C-33 automatic transmission fluids and DEXRON®, or DEXRON® type fluids. Many people falsely believe they are interchangeable or one is better than the other. True, both fluids are usually red, essentially the same viscosity and seal compatibility with good oxidation resistance and wear performance so that for hydraulic and power steering applications they are interchangeable, miscible and compatible.

They differ fundamentally in clutch pack friction characteristics. See friction curves and pictures of clutch packs.

Clutch packs and bands are responsible for power transfer through the transmission and the "shift feel" of gear changes. On the clutch pack and bands the friction characteristics of the fluid, the size, shape and slope or coefficient of the friction curves seen below are critical to ensuring smooth shift, and long clutch pack, band and transmission life. The clutch pack/band area of the transmission generates approx 50% of the heat input to the automatic transmission fluid. The other major heat input is the torque converter.

If excessive slip occurs in the clutch pack/band area of the transmission the fluid is subjected to greatly increased heat stress. The friction material used in the clutch packs and bands will also be degraded.



These are the areas where the friction characteristic of the transmission fluid is critical, particularly if the vehicle (transmission) is in severe or heavy duty service, ie high loads, towing, heavy vehicle, powerful engine. Under these conditions the correct frictional characteristics help ensure the transmissions durability (giving acceptable service life).

## **HOW DO THE FRICTION CHARACTERISTICS OF DEXRON® 11 AND FORD M2-33 FLUIDS DIFFER?**

### **FORD M2C-33 FLUID VS DEXRON® II FLUID:**

Final Dynamic torque (clutch pack friction) before clutch lock-up, up to 50% higher. Breakaway torque (the torque required to make the clutch pack slip), up to 100% higher. Torque or coefficient of friction on the clutch pack decreases as temperature of the fluid increases. The breakaway torque of a DEXRON® type fluid at 40°C is approximately the same as a Ford M2C33 fluid at 150°C. Normal running temperatures of automatic transmission fluid is 95 - 130°C.

Putting a DEXRON® type fluid into an automatic transmission designed for Ford M2C-33 type fluid means the friction on the clutch pack/band will effectively always be the same as the transmission would see in very high stress high load, high temperature conditions. It should be no surprise then that transmissions that specify M2C-33 Ford fluids may fail prematurely if filled with DEXRON® type fluids.

Some people do claim “Universal” performance for some DEXRON® type fluids. Castrol investigations of these claims confirm that performance in heavy duty Ford M2C-33 applications is not guaranteed. The Ford M2C-33 F or G specification specifically excludes the incorporation of friction modifiers, these components are essential in DEXRON® type fluids.

For these reasons Castrol Australia will not claim “Universal” performance for the automatic transmission fluids it supplies.

Finally, Ford M2C-33 fluids should not be used where DEXRON® type fluids are recommended as harsh shifts or squawk (noise during shifting) may be experienced. If DEXRON® type fluid is filled into a transmission where Ford M2C33 fluids are recommended 2 - 3 flushes will be needed to effectively remove the DEXRON® type fluid.

NOTE: For non standard transmission applications such as drag racing CASTROL TQF (Ford M2C-33G) has been successfully used in transmissions where DEXRON® type fluid is normally recommended. In this application “hard” shifts are considered desirable. Any noise or squawk associated with these hard or harsh shifts is not noticed above high engine noise normal in race vehicles.

## **CASTROL AUTOMATIC TRANSMISSION FLUIDS**

Castrol develop, manufacture and market a range of automatic transmission fluids to suit the wide range of transmissions and transmission fluid specifications now found in the Australian market. In the recent past most automatic transmission requirements could be satisfied with one or two automatic transmission fluids. Today four or five are needed to cover all the changed requirements.

In Australia BTR Engineering (previously known as Borg Warner Australia), manufacture automatic transmissions. Ford Australia predominantly utilise BTR Engineering models 85, 91 and 95 transmissions In their current Falcon and Fairlane vehicles.

When specifying automatic transmission fluids for imported vehicles, ensure the correct lubricant is used by consulting the vehicle manufacturers’ handbook. General Motors Holden Automotive have used locally manufactured as well as imported transmissions and recommend DEXRON® type fluids for all transmissions.

## **CASTROL TQ DEXRON® 111 AUTOMATIC TRANSMISSION FLUID**

**CASTROL TO DEXRON® III** fluid is approved by General Motors to the GM 6297 M specification. It supersedes both the Type A Suffix A, Dexron B fluids, Dexron II C, D & E fluids, some of which are still available from Castrol for special applications.

General Motors introduced the DEXRON® III specification (GM 6297M) to achieve improved low temperature operability and improved oxidation stability.

**CASTROL TO DEXRON® III** is also approved against Ford Mercon® and recommended where that performance level is specified.

**CASTROL** have also incorporated improved wear protection and friction durability into the **CASTROL DEXRON® III** (F30603) formulation. Testing has shown dramatic improvement in wear performance in gears subjected to extended periods of high torque input.

The improved friction durability of **CASTROL DEXRON® III** provides smoother shifts and longer clutch pack and band life, particularly in severe duty applications.

The improved friction performance of **CASTROL DEXRON® III** has already proved beneficial in some Japanese automatic transmissions, eg Subaru Liberty.

On-going engine and vehicle development continues to increase performance requirements and drive automatic transmission fluid upgrades. Along with the following factors that increase performance demands on automatic transmission fluids, drivers' expectations of vehicle and automatic transmission performance continue to increase.

- Reduction of under-vehicle air flow to improve vehicle aerodynamics.
- Transmissions being installed closer to vehicle bodies thereby reducing further cooling air flow. On some vehicles the gap between the transmission and car body is completely filled with insulation material for noise reduction.
- Increased boat, trailer and caravan towing capacity.
- Increased city traffic congestion and increased automatic transmission ratio's (gears) means greater number of gear shifts stressing fluid friction durability.
- Improved engine cold start and drive-away performance means automatic transmission fluids need improved cold start fluidity and more stable friction characteristics hot and cold.
- Higher engine performance across a wider engine speed range.
- Better engine performance at high engine speed means higher energy input into clutch packs at full throttle shifts.
- Reduction of size and mass in transmissions and components with improved engine performance means higher power density for transmissions and fluids.
- Minimisation of automatic transmission fluid volume.
- Wide spread use of air conditioning increases heat flow into the engine and transmission compartments and cooling systems.

## **TRANSMAX M**

**CASTROL TRANSMAX M**, previously **CASTROL TO DEXRON® II D21885**, satisfies the requirements of GM 6137M (1975) and is approved by Mercedes Benz (P236.7), ZF (TE-ML 14) and BTR (Eng) for their three speed automatic transmissions (models 39, 40 & 51 ). Castrol Transmax M is also approved for certain Peugeot automatic transmissions.

Licensing requirements precludes reference to DEXRON® on fluids other than DEXRON® IIE fluids from December 31, 1992.

**CASTROL TRANSMAX M** is suitable for a wide range of automatic transmission applications. It is not suitable where Ford M2C-33 or other specialist fluids are recommended. For severe duty applications **CASTROL TO DEXRON® III** or **TRANSMAX Z** (synthetic automatic transmission fluid) are recommended.

### **CASTROL TQF AUTOMATIC TRANSMISSIONS FLUID**

**CASTROL TQF** is approved by Ford Motor Company against specification M2C33-G. (approval number 3PE80080).

The M2C33-G specification requires fluids which provide improved shear resistance and oxidation protection, better low-temperature fluidity, better EP properties and additional seal tests over and above M2C33-F quality fluids.

**CASTROL TQF** has similar physical properties to **CASTROL TQ DEXRON® III** but with very different friction characteristics to suit the requirements of certain Ford and other transmission units. (See specification section).

**CASTROL TQF** is recommended wherever Ford M2C33-F or G is specified. **CASTROL TQF** to M2C33-G specification is the refill and top-up recommendation for Borg-Warner UK transmissions, e.g, Rover, Volvo, SAAB 99 and 900 (pre 1993).

During the early 1980's Ford changed from M2C33-F and G high static fluids to M2C 138-CJ and M2C 166-H low static DEXRONI type automatic transmission fluids in most Ford automatic transmissions. In 1987 Ford USA issued the MERCON® specification encompassing updates on M2C 138-CJ and M2C 166-H and introducing a formal approval system similar to the DEXRON® specification. 'Mercon' is a trade mark of the Ford Motor Company.

Ford currently only specify 'MERCON' fluids for a few vehicles imported from the USA into Australia. **CASTROL TQ DEXRON® III** or **TRANSMAX M** are recommended for 3 speed automatic transmissions in Ford cars (1982 onwards) and **CASTROL TQ 95** for 4 speed transmissions.

## **CASTROL TQ 95**

**CASTROL TQ 95** is an automatic transmission fluid specifically formulated to suit the BTR Engineering Models 85, 91 and 95. These 4 speed electronically controlled automatic transmissions are used in Ford Falcon and Fairlane models.

**CASTROL TQ 95** is the end result of approx five year development between BTR Engineering and Castrol Australia.

**CASTROL TQ 95** is used for factory fill in BTR Engineering Models 85, 91 and 95.

**CASTROL TQ 95** has enhanced gear set wear protection and friction characteristics tailored to suit the BTR Engineering 4 speed electronically controlled transmissions used in Ford Fairlane and Falcon cars. **CASTROL TQ 95** also has very stable friction and viscosity stability characteristics vital for electronically controlled transmissions. These characteristics help ensure smooth shifting and enhanced transmission durability.

**CASTROL TQ 95** has shown improved shift smoothness in Honda vehicles compared to DEXRON® IID fluids and is recommended for most late model Honda Cars.

Refer to Product & Technical Data Sheet B835/90/2 for further information.

## **CASTROL TQ M-SP**

**CASTROL TQ M-SP** is an automatic transmission fluid specially formulated to suit Mitsubishi, Hyundai and Proton automatic transmissions, especially those fitted with damper clutches.

**CASTROL TQ M-SP** has friction characteristics tailored to the requirements of Mitsubishi, Hyundai and Proton automatic transmissions fitted with damper clutches. The particular characteristics are required for smooth damper clutch and transmission performance and shifting. They also improve transmission durability. **CASTROL TQ M-SP** is not recommended for the automatic transmissions of other vehicles or Mitsubishi vehicles with Borg-Warner (BTR Eng) automatic transmissions.

## **CASTROL TRANSMAX Z**

**CASTROL TRANSMAX Z** is a full synthetic automatic transmission fluid with excellent oxidation and friction stability.

**CASTROL TRANSMAX Z** is a DEXRON® III type automatic transmission fluid intended to satisfy both DEXRON® III and II requirements. It is designed and proven to give smooth shift and long life in passenger car and heavy duty automatic transmissions. It has been approved by JATCO against NISSAN MATIC D requirements for service fill.

**CASTROL TRANSMAX Z** is a product designed for severe duty applications and long drain service. Field experience in Australia has already demonstrated outstanding performance in heavy duty transmissions in buses and coaches particularly those fitted with internal retarders. It has also reduced transmission fluid temperatures in severe duty applications, improved shift performance in transmissions where mineral DEXRON® type fluids were unsatisfactory. **CASTROL TRANSMAX Z** has proved very successful in drag racing applications, both in Jenco Pro-Stock and Powerglide transmissions.

**CASTROL TRANSMAX Z** is compatible with conventional mineral oil based automatic transmission fluids and normal seal materials, however intermixing will reduce fluid performance. **CASTROL TRANSMAX Z** is suitable for most types of automatic transmissions except where Ford M2C-33 fluids are recommended.

**CASTROL TRANSMAX Z** is recommended against Ford Mercon® and Mercon® V specifications.

Refer to Product & Technical Data Sheet B901/92/2 for further information.

## **CASTROL TFC 400 SERIES**

Castrol have a range of special commercial transmission fluids, CASTROL TFC 410, 430 and 450, specially formulated to satisfy Allison C4, Caterpillar TO-4 and Komatsu micro-clutch requirements. These products are our prime recommendations for various Allison, Caterpillar and Komatsu transmission requirements.

Please refer to Product & Technical Data Sheet Castrol TFC 400 Series transmission fluids 8919/92/2.

## **SELECTION OF AUTOMATIC TRANSMISSION FLUID**

1. Only use those fluids recommended in the Vehicle Manufacturers Handbook or on Castrol Data Sheets.
2. Vary the recommended fluid only on the advice of a recognised transmission expert familiar with the transmission who could have altered the frictional requirements in service or repair. 3. Generally, CASTROL TQF fluid as top-up, is only suitable in an emergency for units designed and initially filled with Dexron fluids; however, a harsher change or 'squawk' may be experienced if added in too large a proportion without specialised adjustment of the transmission.
4. It is generally not recommended to top-up transmissions designed to operate on TQF with Dexron type fluids as clutch slip may develop.
5. In an extreme emergency either Dexron or TQF may be used, provided the transmission is drained and refilled with the recommended fluid at the first opportunity.

**CAUTION:** Always ensure the manufacturers' recommendations are followed.



## **OTHER APPLICATIONS FOR AUTOMATIC TRANSMISSION FLUIDS**

Other applications for automatic transmission fluids are:

- certain non-automatic gear boxes (factory and service fill)
- industrial and agricultural equipment, including fluid couplings and transmission systems (hydraulic fluid)
- hydraulically-operated ship hatch covers (low temperature hydraulic fluid with minimum stickslip properties)
- power steering mechanisms (hydraulic fluid).

## **SERVICE OF AUTOMATIC TRANSMISSIONS**

Automatic transmissions are of advanced engineering design and are manufactured to extremely close tolerances. That is especially true of the valve control spools where the presence of minute particles of dirt in the transmission fluid will promote erratic valve movement and possibly complete failure of the transmission. Long and trouble-free operation can be expected, provided the manufacturers' servicing instructions are followed and the procedures listed below are typical.

**WARNING:** Ensure vehicle hand brake is on and drive wheels are chocked against movement.

1. When checking fluid levels, bring engine and transmission to normal operating temperatures and place gear selector in NEUTRAL or PARK, with the engine idling. Ensure vehicle is on level ground.
2. Before attempting to remove the dipstick, thoroughly clean area around dipstick opening to ensure no dirt can fall into the transmission when the dipstick is removed.
3. Use lint-free cloth or absorbent paper to wipe dipstick free of fluid.

4. Always rely on the dipstick reading to determine the amount of fluid to be added, and not on the published capacities.
5. Under no circumstances over fill the transmission. Too much fluid will cause unsatisfactory transmission operation through excessive foaming, heating and pressure generation. These may lead to transmission fluid being lost out of the dipstick tube which may find its way onto a hot exhaust system causing a fire.
6. When adding fluid, use clean dispensing equipment and avoid contamination with other lubricants and solvents.

## **FLUID REPLACEMENT - DRAIN PERIOD**

The general recommendation of automatic transmission manufacturers requires fluid changes occur during actual servicing or adjustment of the transmission; therefore, drain plugs have been eliminated from many units. Typical service intervals are in the range of 40 - 80,000 km, more often in severe service like towing, taxis etc.

Automatic transmission fluids are being subjected to increasingly severe operating conditions, and only by regular draining can the following be attained:

- Removal of dirt and moisture (condensation) from the unit that may have been drawn into the housing on cooling.
- Removal of oxidised fluid contaminants where high temperatures have been experienced.
- During service, the anti-corrosion, anti-oxidant and detergent/dispersant properties of the fluid may be eventually consumed. The fresh fluid charge restores these properties to their full effectiveness.

Castrol recommends for optimum transmission performance the fluid be replaced every 2 years or 40,000 km particularly for vehicles involved in caravan or heavy trailer towing, taxi service or high speed driving.

*This Product & Technical Data sheet supersedes B 764/89/2*

## TYPICAL CHARACTERISTICS OF CASTROL AUTOMATIC TRANSMISSION FLUIDS

Grade	Density @ 15°C	Kinematic Viscosity		Viscosity Index	Viscosity @ -40°C (cP)	Pour Point °C	Closed Flash Point °C	Colour
		@ 100°C (cSt)	@ 40°C (cSt)					
TRANSMAX Z	0.836	7.1	36	170	8,400	Below - 60	226	Green
TQ Dexron III	0.871	8.30	37.8	210	20,000 Max	- 48	185	Red
TRANSMAX M	0.873	7.15	37.4	160	50,000 Max	- 40	185	Red
TQF	0.878	8.25	38.4	180	50,000 Max	- 45	177	Red
TQ95	0.874	7.45	38	160	40,000	- 40	185	Red
TQM-SP	0.870	7.30	36.3	171	20,000 Max	- 45	182	Red

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