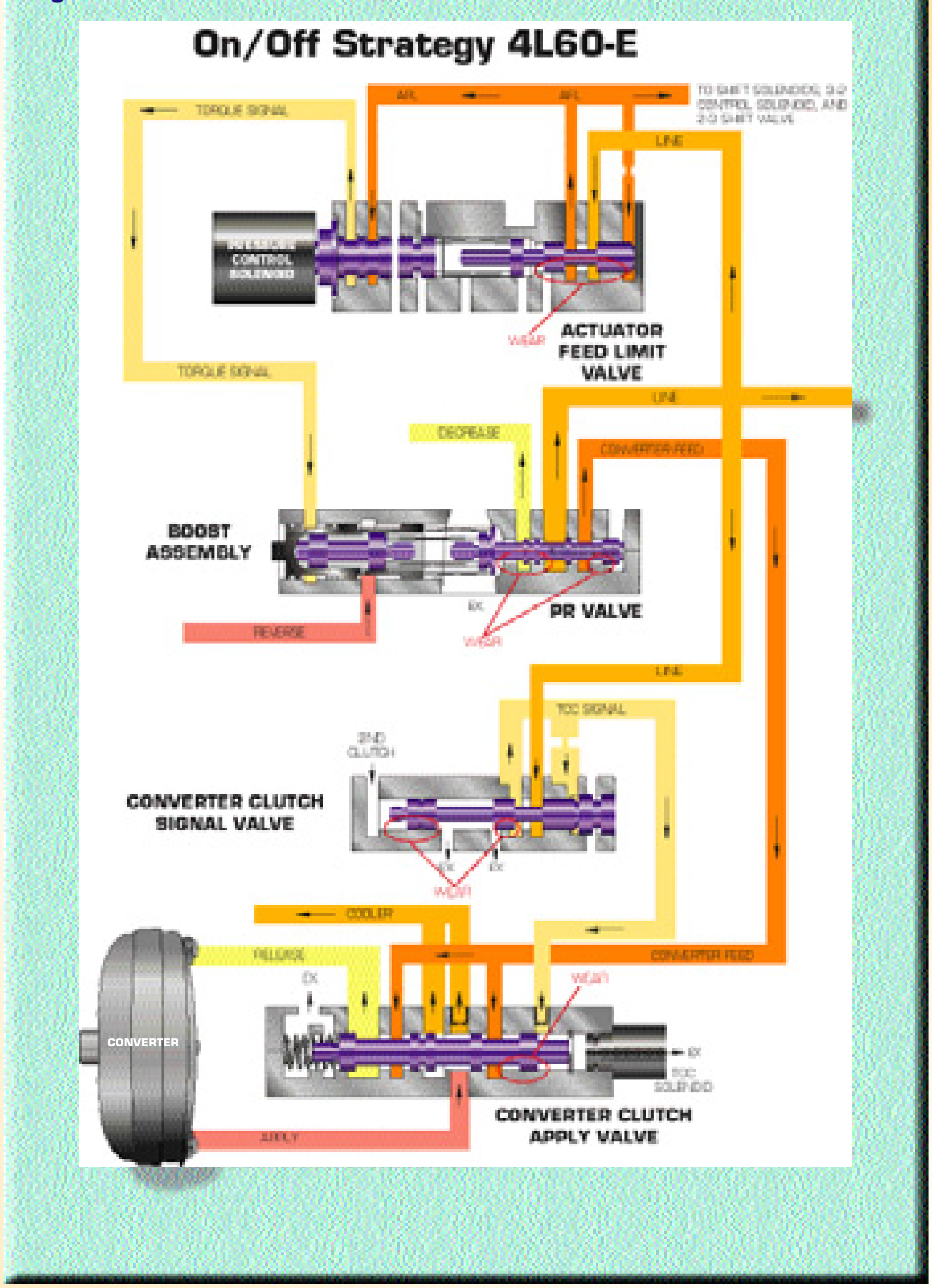
1870 DTC, TCC, AFL, PWM, EC³, etc.

By Maura Stafford

Enough with all the abbreviations and acronyms – just tell me which valve fix I should use! This is a common sentiment expressed to Sonnax sales and technical staff. The 1870 code is aggravating enough to experience, and often times more frustrating to try to diagnose, repair, and understand. We truly wish it was as simple as changing a light bulb due to a burned out filament, but the unfortunate reality is that there are too many hydraulic, electronic, and hard parts involved in the TCC (torque converter clutch) circuit to make it that easy. The *EC³ and PWM Converter Clutch Solutions* article on page 90 explains the importance of selecting appropriate converter friction linings to prevent 1870 codes. This article will examine the different hydraulic valves in the TCC circuit and clarify how they can contribute to the 1870 code, as well as providing some quick and easy ways to look for causes, and recommend solutions.

Figure 1



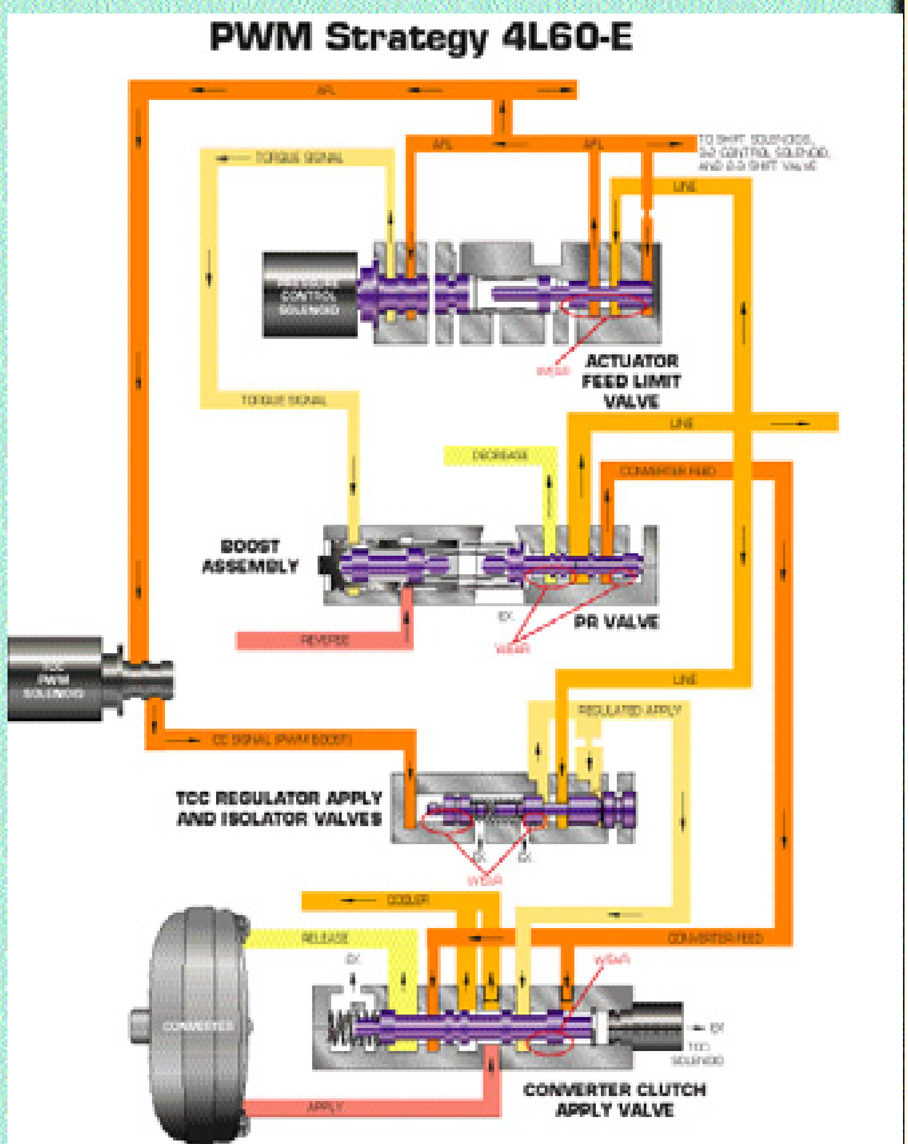
On/Off, PWM or PWM w/EC³?

General Motors has used a number of different strategies in the operation of the converter clutch, which can basically be categorized as On/Off, PWM (pulse width modulated), and PWM with EC³ (electronically controlled capacity clutch). It's important to understand the differences, as some parts won't interchange between strategies and bench fixes that worked for one strategy will cause comebacks in others.

The On/Off strategy *(Figure 1)* operates the converter clutch as purely on or off. The one piece converter clutch signal valve is stroked by 2nd clutch fluid pressure in 2nd, 3rd, and 4th gears to direct TCC signal fluid to between the converter clutch apply valve and the TCC solenoid in the pump. During converter release, the signal oil is exhausted through the normally open TCC solenoid. When the PCM (power control module) commands apply, the TCC solenoid is energized, and signal oil strokes the converter clutch apply valve, which applies the converter clutch.

The PWM strategy *(Figure 2)* added a TCC PWM solenoid to control fluid acting on the TCC regulator apply and isolator valves, which replaced the one-piece converter clutch signal valve. This was designed to provide smooth engagement of the torque converter by operating on a negative duty cycle percentage of “ON” time, and allowing the converter clutch to briefly slip or ease onto the cover. Line pressure, biased by CC signal oil, becomes regulated apply pressure at the TCC regulator valve, and is directed to the converter clutch apply valve. In the PWM circuit this apply pressure is ***not*** fed to the ***end*** of the apply valve, but to ***between*** the first two apply valve spools. Thus, when the valve strokes, this regulated apply oil is sent directly to the converter.

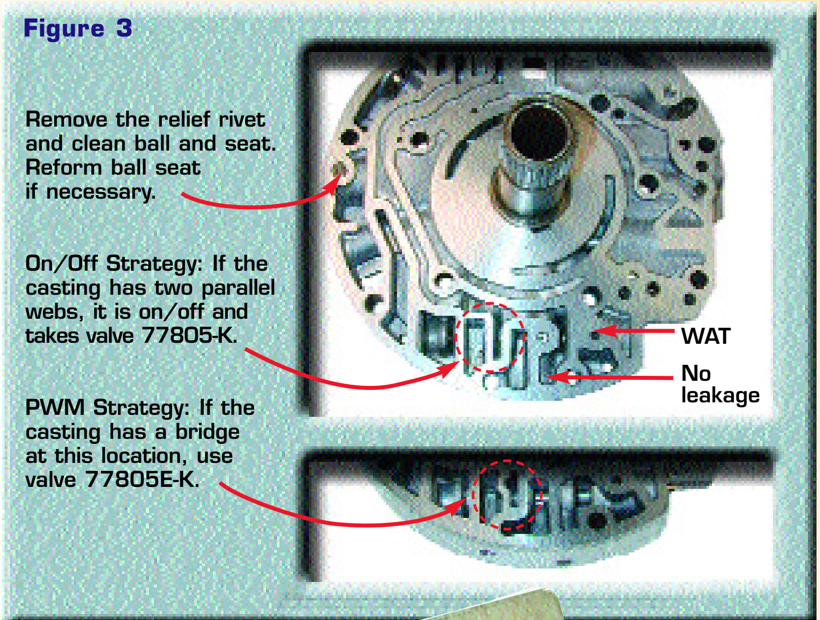
Figure 2



The 3rd and latest GM strategy is the addition of EC³ to the PWM design. In this strategy, the converter clutch now begins to apply in 2nd gear, and is allowed to slip until the vehicle reaches 55mph, at which time the clutch fully applies. The oil circuitry and valves remain the same as on the PWM, but the converter lining was changed to a woven carbon material in order to handle increased heat.

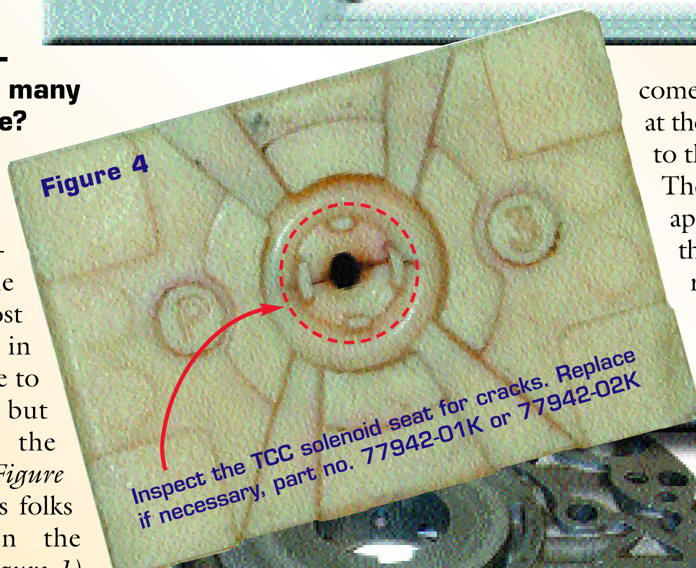
How can the converter clutch apply valve contribute to an 1870 code?

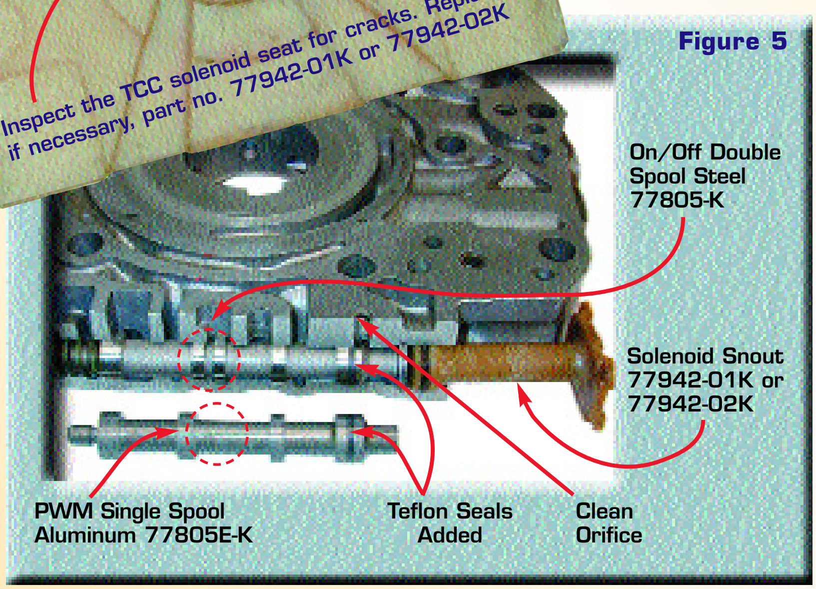
This is the directional valve that actually routes fluid pressure to the apply or release side of the converter clutch. It is common for the valve bore to wear at the spool area closest to the TCC solenoid. When this occurs, oil cross leakage between converter feed and TCC signal or regulated apply overcomes the ability of the solenoid to exhaust and begins to prematurely stroke the apply valve, creating excessive clutch slippage. A wet air test is a simple and quick method for checking for wear at this location *(Figure 3)*. A cracked TCC solenoid snout *(Figure 4)* can reduce apply pressure by allowing the oil pressure designed to stroke the valve to exhaust instead, thus causing an 1870 code. In 1997, the simple cup-plug style TCC solenoid feed orifice was upgraded to a metal housing with a plastic insert to alleviate drain-back concerns. If exposed to severe heat, this plastic insert can melt and clog the orifice or cause the valve to hang-up, again leading to an 1870 code. There are valve spool differences between the On/Off and PWM versions of the converter clutch apply valve *(Figure 5)*, and installing an On/Off valve into a PWM pump will cause a no cooler flow condition in lock-up.



What's up with the TCC Regulator Valve? How many versions are there? And why can't I just block the valve?

The TCC regulator valve for the 4L60-E is the most confusing valve in the circuit, not due to its function, but because of all the changes by GM *(Figure 6)* and bench fixes folks have devised. In the On/Off units *(Figure 1)*, this one-piece converter clutch signal valve was designed to route TCC signal oil pressure to the converter clutch apply valve in the pump in order to stroke the apply valve when 'signaled' by the TCC solenoid. This steel signal valve would tend to wear the aluminum bore at the circled areas, allowing 2nd clutch and TCC signal oil pressures to exhaust. Both areas of lost pressure would have the same effect: diminished TCC signal pressure. Because this is the pressure that strokes the converter clutch apply valve, this could reduce apply pressure and cause clutch slippage.





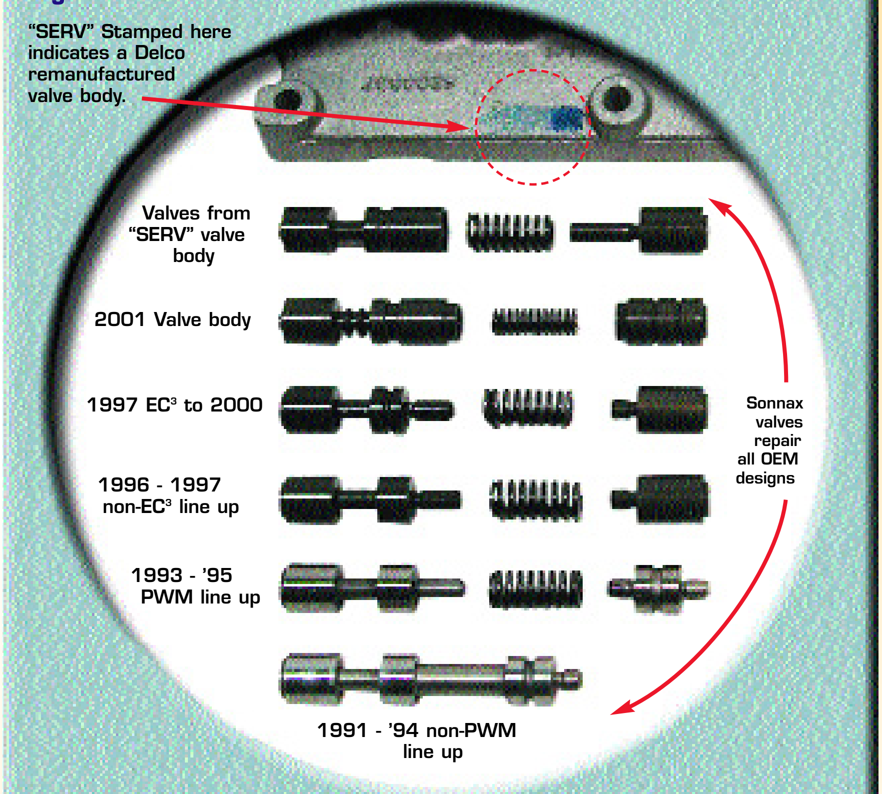
When GM went to the PWM strategy (Figure 2), they divided this valve into two pieces: the isolator and regulator valves. The isolator valve is acted upon by pulsed CC Signal oil from the TCC PWM solenoid. This pressure allows the isolator valve to fine-tune the position of the regulator valve in accordance with the commanded solenoid duty cycle. Line pressure becomes regulated apply oil, ***not*** signal oil, at the TCC regulator valve and gets routed to the converter as actual apply pressure. The 'signal' pressure at the end of the apply valve now comes directly from the converter feed circuit at the pressure regulator valve. Wear at the isolator valve allows CC signal oil to exhaust, preventing proper stroking of the regulator valve. Wear at the regulator valve allows regulated apply oil to exhaust, robbing apply pressure from the converter.

Two common industry fixes for worn regulator bores are to block the regulator valve into the maximum apply position or grind a flat on the outboard valve spool. While these do not stop the oil from leaking and diminishing pressure, they do keep most of the signal pressure going to the end of the apply valve in On/Off units. If the apply valve bore and TCC solenoid are in good condition, this may be enough to keep an On/Off unit on the road for a considerable time. However, if the apply valve bore is worn, converter feed pressure may combine with TCC signal oil pressure and be too much for the solenoid to exhaust, prematurely stroking the apply valve.

If the same regulator valve blocking techniques are used on a PWM or EC³ unit, results will be quite different. These two strategies require ***regulated*** apply pressure in order to control the slip during converter clutch apply. If the regulator valve is blocked into the maximum regulated apply pressure position or the spool is ground, then not only is regulation not occurring, but ***converter apply pressure is now equal to line pressure.*** Remember, this regulated apply pressure is no longer feeding the end of the apply valve, but being routed directly to the converter clutch. Normal apply pressure is 15-80 psi, but with a blocked or ground valve, apply pressure reaches 140 psi. This can put up to 14,000 pounds of force on the converter clutch. The converter clutch linings used in the PWM and EC³ units are designed for their slippage characteristics, and do not handle the resultant harsh impact well. The results will be premature and bumpy applies, and converter overheating and/or failure.

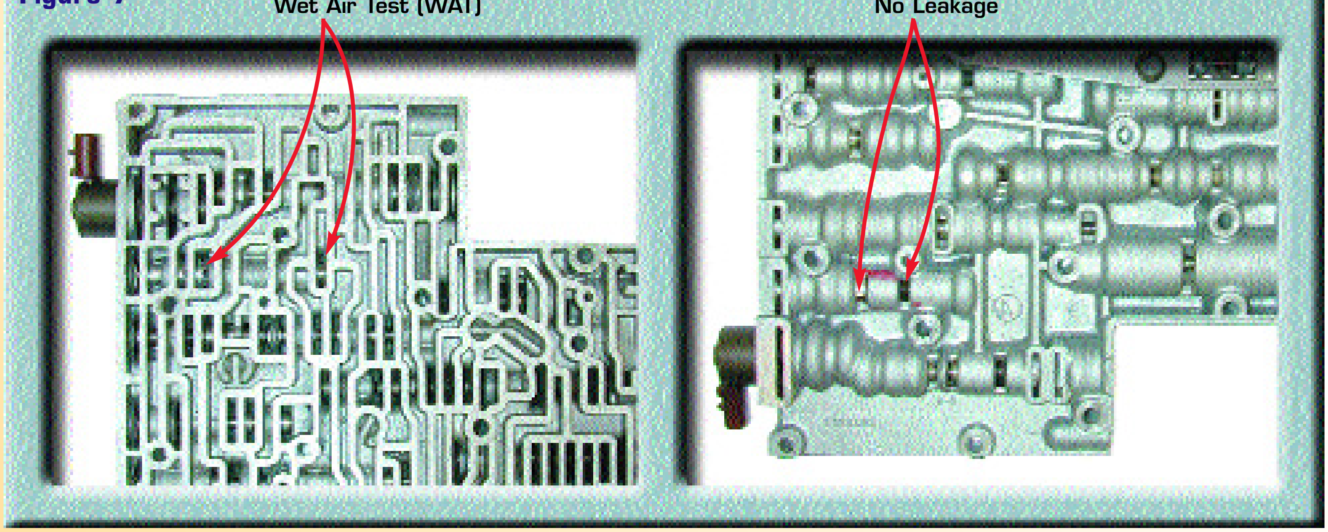
While blocking or grinding the TCC regulator valve may temporarily clear the 1870 code, it does ***not*** stop the line pressure leakage in this location. Long-term durability, converter ballooning, drivability complaints due to low line pressure, and 2-4 band and 3-4 clutch failures are just some of the problems that can arise due to unaddressed

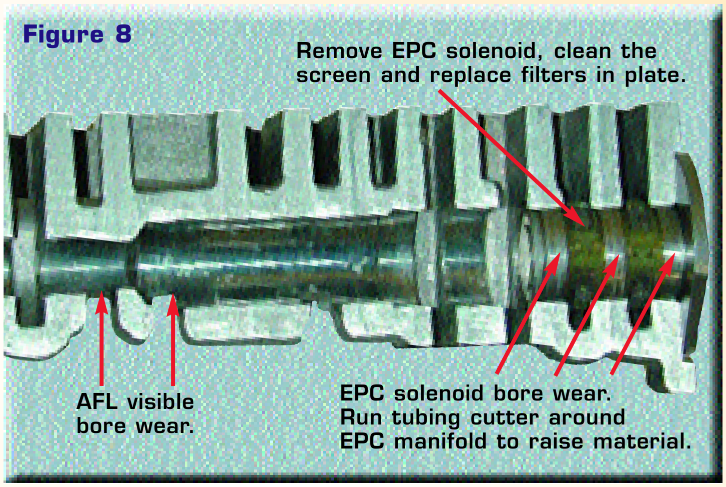
Figure 6



TCC Regulator Valve Design Variations

Figure 7





line pressure leakage at the TCC regulator valve.

Wet air tests can be easily performed *(Figure 7)* to check for bore wear at the isolator and regulator valves. Sonnax offers two TCC regulator valve kits, 77754-03K and –04K, and an isolator sleeve, 77754-ISO, which will allow the repair of any of GMs valve line-ups, including the Delco remanufactured valve bodies. Details on these can be found on their individual product pages, 74 and 75. Essentially, the 77754-03K is designed with a slightly increased TCC apply rate, and should only be used on non-EC^3 units. The 77754-04K offers a stock TCC apply rate, and can be used on all three GM strategies. The 77754-ISO is a sleeve for the Sonnax isolator valve, and may be used in conjunction with the -03K and -04K kits for all strategies if severe isolator bore wear is present.

How can the actuator feed limit valve contribute to an 1870 code?

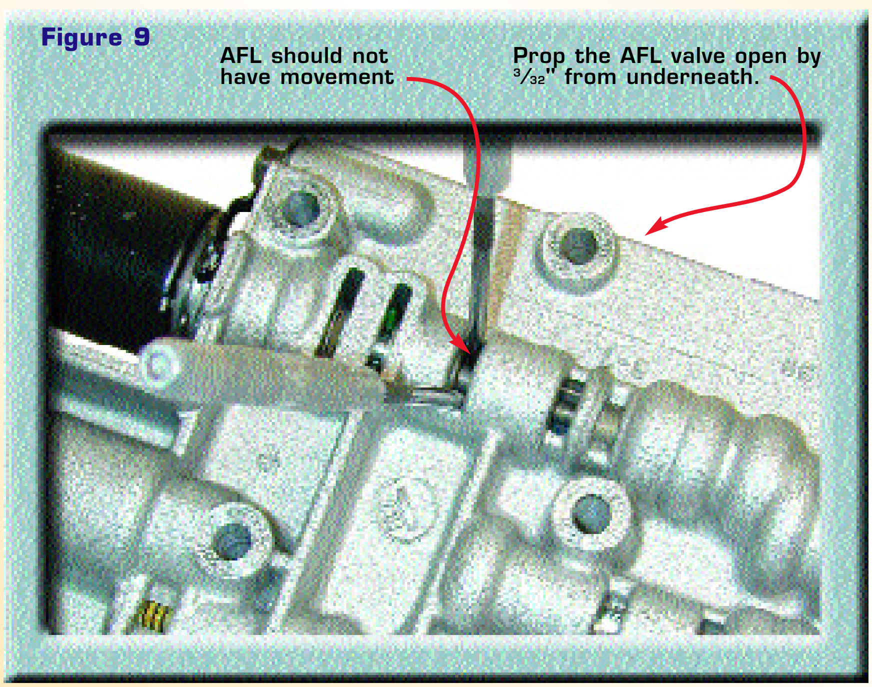
In PWM strategies, AFL oil is regulated line pressure that is routed to the TCC PWM solenoid, where it becomes CC signal pressure. AFL pressure is limited to 115psi, and matches line pressure up to that point. The TCC PWM solenoid pulses the percentage of on time, thereby adjusting the CC Signal pressure. Due to extreme side-loading of the AFL valve, the bore wears significantly *(Figures 1 & 2)* and allows AFL pressure to exhaust. This reduced AFL pressure translates into reduced CC signal pressure, and onward to reduced apply pressure and excessive converter clutch slippage. While AFL pressure has a more direct impact on TCC performance in PWM units, it can still affect apply pressure in On/Off strategies by reducing torque signal pressure and its affect on line rise at the boost valve assembly.

The AFL bore is difficult to wet air test. There are two options for detecting wear: remove the valve and look through the casting ports at the indicated areas for wear *(Figure 8)*, or pry the valve slightly from both sides of the stem and look for a loose fit *(Figure 9)*. Sonnax offers a redesigned AFL valve with a wear resistant sleeve, page 84, which can be used to refurbish this bore.

Can pressure regulator valve bore wear or a worn boost valve assembly contribute to an 1870 code?

Yes, by reducing line rise. If main line pressure is allowed to exhaust, it will diminish both AFL pressure and regulated apply pressure (PWM) or TCC signal pressure (non-PWM). The boost valve wear will allow torque signal pressure to exhaust, preventing the pressure regulator from being stroked to the high line pressure position. Wear at the pressure regulator valve bore allows line pressure to bleed to decrease, resulting in poor line rise.

The boost valve assembly may be removed from the pump and easily wet air tested at the bench, or left in the assembled pump and wet air tested *(Figure 10)*. Sonnax offers replacement assemblies for this application, as seen on page 85. The pressure regulator bore is difficult to wet air test, but can be checked for excessive side-to-side movement *(Figure 11)*. Sonnax offers an oversized pressure regulator valve, on page 70, that allows the bore and hydraulic integrity to be refurbished.



So our best advice in resolving any pump or valve body related code 1870 problems is to check each of these locations for bore wear or valve malfunctions. A reference chart for quick valve checks has been compiled *(Figure 12)*. The 4T60-E TCC circuitry is very similar to that of the 4L60-E, so valves to check to correct an 1870 code in that application are given as well. The time invested in performing wear tests will prevent comebacks and save time, headaches, and money in the future.

Figure 10

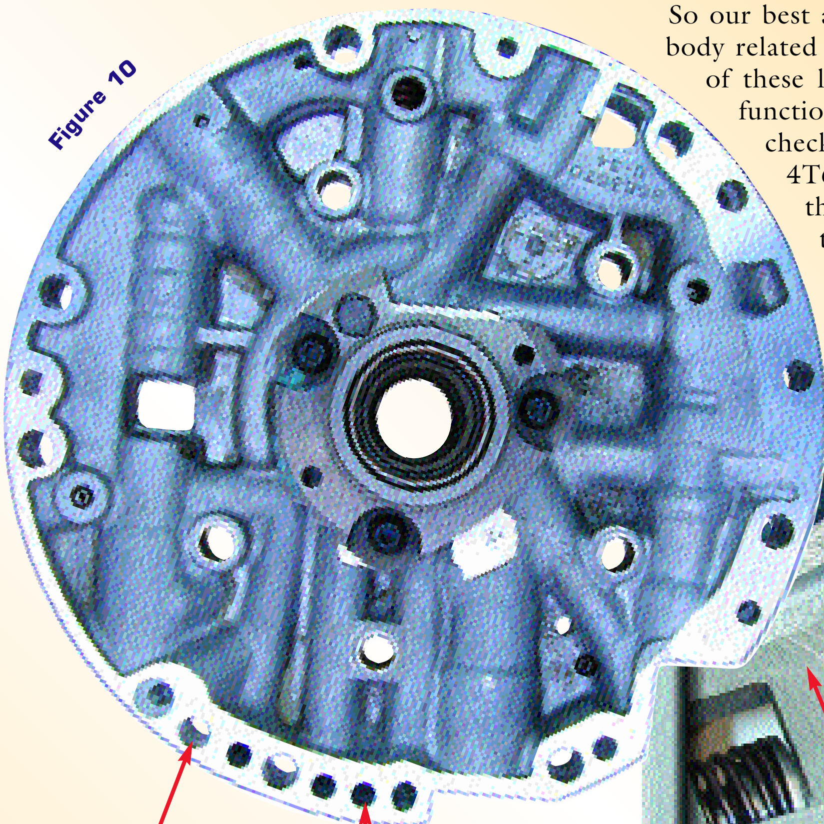


Figure 11

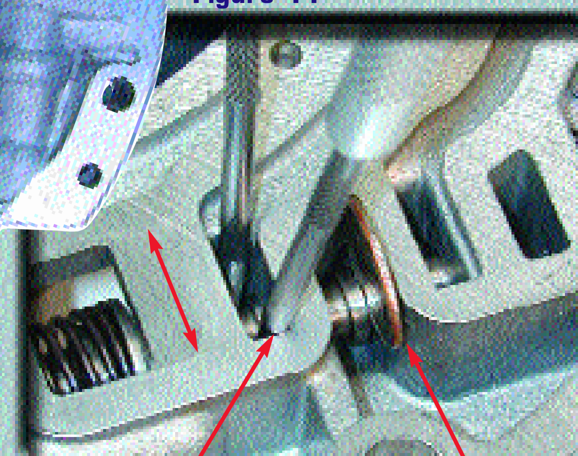


Figure 12

CODE 1870 VALVE CHART

	VALVE CHECK LIST	COMMON SYMPTOMS ACCOMPANYING 1870	WEAR TEST	SONNAX PART NO.
4L60-E	Converter Clutch Apply Valve	Falls out of L/U hot; no L/U; L/U right after 2nd gear	WAT, Fig. 3	77805-K, 77805E-K
	TCC Solenoid Snout	TCC apply problems; overheated converter; lube loss	Visual, Fig. 4	77942-01K, 77942-02K
	TCC Regulator Valve (PWM) TCC Isolator Valve (PWM) CC Signal Valve (non-PWM)	TCC apply problems; overheated converter; harsh 1-2; burned 3-4 clutch	WAT, Fig. 7	77754-03K, -04K, -ISO
	Actuator Feed Limit Valve	Wrong gear starts; solenoid codes; clutch/band failure	Visual, Fig. 8 & 9	77754-09K
	Pressure Regulator Valve	Low line psi; 3-4 clutch failure; excessive pump noise	Visual, Fig. 11	77917-07
	Boost Valve	Insufficient line rise; 3-4 clutch failure; poor shift quality	WAT, Fig.10	77898E-K, -3K, -4K, -6K
4T60-E	TCC Apply Valve	Slip rates > 10%; sudden 150 rpm increase in engine rpm	WAT & Visual	84754-16K, -22K, -97K, -98K
	TCC Regulator Valve	Slip rates < 10%; rates gradually increase with load	WAT	84754-01K, -08K
	TCC Isolator Valve	Code 39/740; converter shudder; converter overheat		
	Pressure Regulator Valve	Low line rise; poor shift quality	Visual	
	Modulated Boost Valve	Low line rise; soft shifts; 2nd and 3rd clutch distress	WAT	84754-12K, -17K