

LSA : Lobe Separation Angle

La version anglaise du document est située à l'adresse suivante :

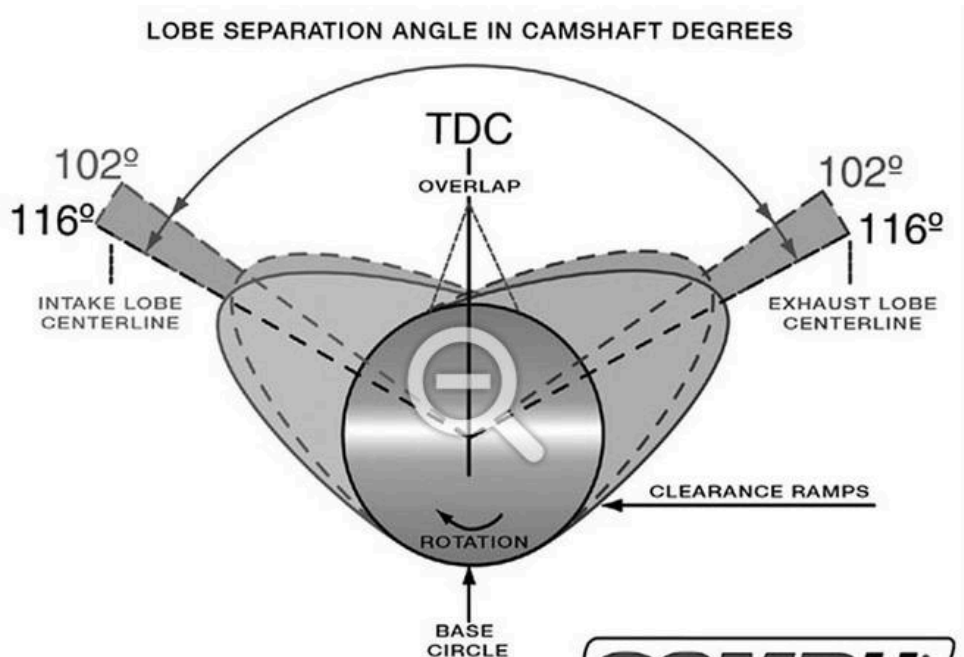
http://www.dragracingonline.com/technical/2011/xiii_7-camshaft-2.html

LSA : L'Angle de Séparation des Lobes (LSA) est défini par le nombre de degrés de rotation du vilebrequin entre le point de montée maximale de la came d'échappement et le point de montée maximale de la came d'admission (axe des cames). Le **LSA** peut être mesuré en utilisant un comparateur et une roue gradué en degrés, mais il est généralement calculé en additionnant l'angle de l'axe de la came d'admission + l'angle de l'axe de la came d'échappement puis en divisant cette somme par 2.

Le **LSA** affecte le temps de chevauchement des soupapes qui se produit autour du PMH et qui se détermine en mesurant l'angle de rotation du vilebrequin quand les 2 soupapes sont ouvertes en même temps. Le chevauchement des soupapes affecte la courbe de puissance, la qualité du ralenti et la valeur de la dépression au ralenti.

Un **LSA** étroit se traduit par + de chevauchement de soupapes et est souvent recommandé pour des véhicules à aspiration naturelle. Un **LSA** plus large réduit l'angle de chevauchement des soupapes et est souvent recommandé pour des véhicules suralimentés.

Un effet curieux et bénéfique d'un chevauchement de soupapes bien calculé produit un balayage efficace dans la chambre de combustion. La vitesse de sortie des gaz brûlés dans la tubulure d'échappement aspire instantanément et directement le mélange comburant dans la chambre de combustion par la pipe d'admission.



La photo originale est située à l'adresse :

<http://garage.grumpysperformance.com/index.php?threads/how-your-cam-lsa-affects-your-compression-torque-dcr.1070/page-2>

Comparaison entre un LSA étroit et un LSA élargi

EFFECTS OF CHANGING LOBE SEPERATION ANGLE (LSA)	
Tighten (smaller LSA number)	Widen (larger LSA number)
Moves Torque to Lower RPM	Raise Torque to Higher RPM
Increases Maximum Torque	Reduces Maximum Torque
Narrow Power band	Broadens Power Band
Builds Higher Cylinder Pressure	Reduce Maximum Cylinder Pressure
Increase Chance of Engine Knock	Decrease Chance of Engine Knock
Increase Cranking Compression	Decrease Cranking Compression
Increase Effective Compression	Decrease Effective Compression
Idle Vacuum is Reduced	Idle Vacuum is Increased
Idle Quality Suffers	Idle Quality Improves
Open Valve-Overlap Increases	Open Valve-Overlap Decreases
Closed Valve-Overlap Increases	Closed Valve-Overlap Decreases
Natural EGR Effect Increases	Natural EGR Effect is Reduced

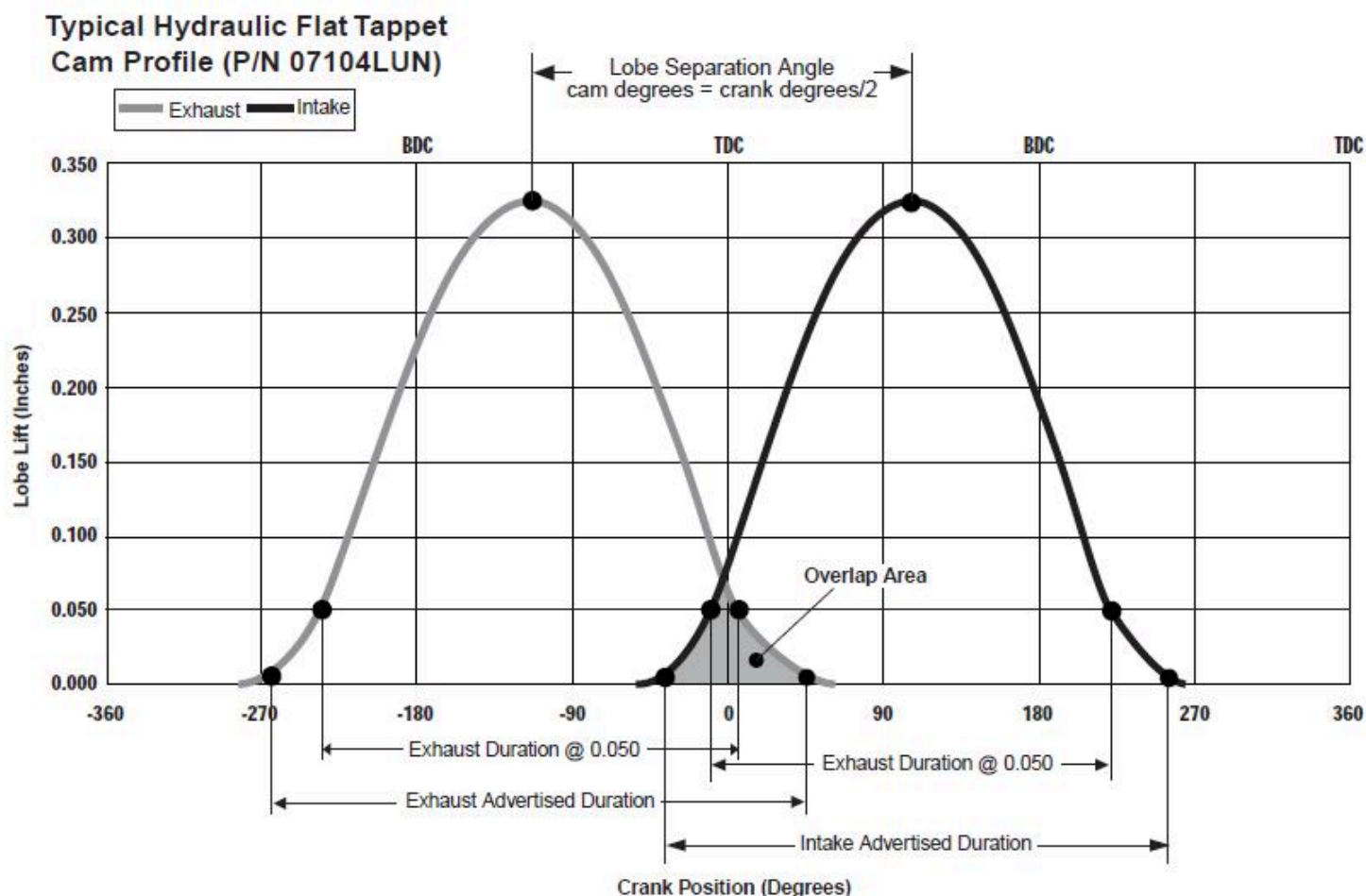
Calage de l'arbre à cames

La version anglaise du document est située à l'adresse :

<http://www.musclecardiy.com/performance/camshaft-math-design-competitive-performance-engines/>

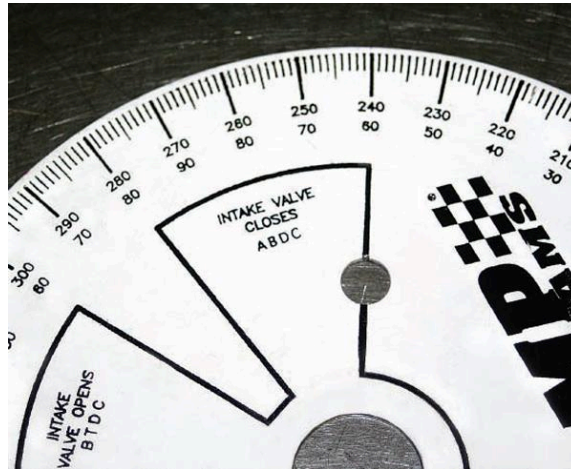
Il y a 2 méthodes pour caler l'arbre à cames. La première compare le point d'ouverture et de fermeture de la soupape d'admission pour voir si cela correspond à la "cam card". La seconde méthode détermine la position de la "centerline" du lobe de la came d'admission par rapport au TDC (PMH).

Les 2 méthodes sont efficaces, mais la méthode de la "centerline" de l'admission ne vérifie pas la conformité des points d'ouverture et de fermeture en accord avec la "cam card". Les 2 méthodes sont décrites ci-dessous mais la méthode d'ouverture et de fermeture de l'admission est recommandée pour un réglage initial. Vous pouvez alors vérifier votre travail avec la méthode de la "centerline" de l'admission. Dans tous les cas vous avez besoin d'un comparateur pour mesurer les déplacements.

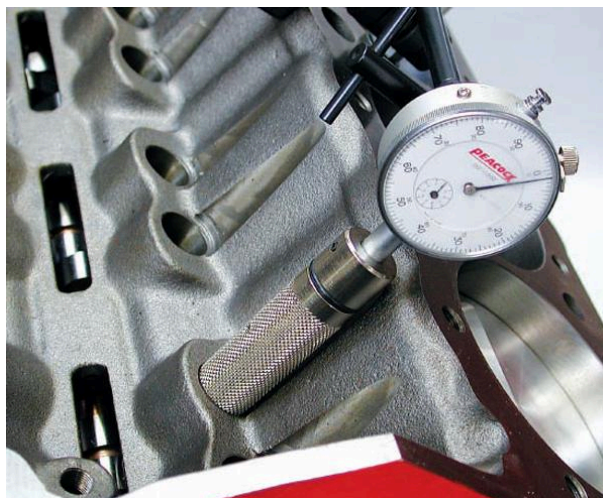


Méthode de réglage sur l'ouverture à l'admission

Installer le disque de mesure en l'alignant correctement à votre moteur. Installer le comparateur et vérifier la mesure de la montée sur la soupape d'admission du cylindre n°1 comme décrit plus haut. Faire le zéro du comparateur et faire tourner le moteur dans le sens normal de rotation pendant plusieurs tours pour vérifier que le comparateur lit bien la course entière de la soupape et revient bien à zéro à chaque tour. Vous pouvez vérifier en même temps que la course corresponde bien à la course de la montée de la came dans la "cam card". Si le doigt du comparateur ne revient pas à zéro sur son cercle de base, alors il faut en déterminer la cause et corriger avant de continuer.



Sur les roues graduées de qualité sont indiqués les secteurs ou normalement les événements des soupapes se produisent. Si vous mesurez un événement qui se produit en dehors de ces secteurs, c'est probablement incorrect et vous devez vérifier votre travail.



Ce comparateur adapté mesure directement le mouvement de montée d'une came sans l'aide d'un comparateur munie d'extension à ressort. Mais il ne peut être utilisé que si la culasse du moteur est démontée, c'est la méthode la plus précise.



Vous pouvez lire la course de la soupape en installant directement le comparateur sur la coupelle de retenue de la soupape. Cette méthode inclue le ratio du culbuteur et tous les jeux pour donner une indication précise du mouvement réel de la soupape

Une fois le comparateur bien réglé, commencer par faire tourner doucement le moteur dans le sens des aiguilles d'une montre jusqu'à ce que le comparateur indique 0.050-inch (1.27 mm). Relever l'angle sur la roue graduée. Cette valeur est à comparer au point d'ouverture (Intake Opening point : IO) indiqué sur la "cam card" pour une levée de 0.050-inch. Continuer à tourner le moteur jusqu'à l'élévation maximale puis descendre de l'autre côté du lobe jusqu'à atteindre 0.050- inch d'élévation avant le point de fermeture (Intake Closing point : IC).

Puisque vous connaissez l'élévation du lobe (lobe lift) et le point de fermeture sur la "cam card", vous devriez être capable d'anticiper le point de fermeture quand vous tourner le moteur. Si vous le ratez, revenir simplement de 60 degrés pour compenser le jeu de la chaîne de distribution et approcher à nouveau les 0.050-inch avant le point de fermeture. Comparer les résultats avec ceux du "cam card" et ensuite continuer la rotation pour vérifier que le comparateur revient bien à zéro

Les données du "cam card" devrait préciser les points d'ouverture et de fermeture de l'admission et la hauteur total du lobe de came. Si le relevé d'ouverture de l'admission ne correspond pas avec les données du "cam card", vous devez avancer ou retarder la cam pour la caler par rapport au spec.

Par exemple, si votre came est supposée ouvrir la soupape d'admission à 36 degrés avant le PMH (BTDC) et se refermer 70 degrés après le PMH (ATDC) à 0.050-inch, mais que votre mesure montre qu'elle s'ouvre 34 degrés avant le PMH (BTDC) et se referme 72 degrés après le PMH (ATDC), la came est retardée. Le mouvement de la soupape se produit plus tard que la valeur recommandée. Si elle s'ouvrait à 38 degrés avant le PMH (BTDC) et se refermait à 68 degrés après le PMH (ATDC) elle serait en avance de 2 degrés parce que le mouvement de la soupape se produit 2 degrés plus tôt que spécifié.

In either case it is easy to correct using offset cam bushings or a crank gear with multiple keyways. Both allow you to adjust the position of the cam and then recheck it for compliance with the cam card specs. Note that they can also be used to reposition the cam if you deliberately choose to advance the cam to promote lowend torque or retard the cam for a little more top end power.

If your degree results are plus or minus 1 degree of your published specs, consider leaving the engine as assembled because it is entirely possible that the small degree wheel you are probably using is not that accurate. Larger-diameter degree wheels space the degree marks farther apart and, therefore, have a greater chance of improved accuracy.

You can check the accuracy of your wheel by placing it on a large sheet of paper and marking the four 90-degree positions of the wheel. Then move the wheel to various positions and check to see that each 90-degree mark is an equal number of degrees from 90. You may well find that your wheel is not completely accurate. This is why fussing over less than 2 degrees (unless for example, the cam is retarded 2 degrees and you want 2 degrees advanced) may not be worth the effort.

Intake Centerline Method

The intake centerline method finds the location of the intake lobe centerline relative to TDC. The recommended intake centerline is indicated on the cam card, and when correct it should yield the specified intake opening and closing points when you degree the cam. Finding the centerline is easy.

Rotate the engine clockwise until you find the maximum lobe lift, then zero the indicator. Now rotate backward about 0.100 to 0.150-inch to compensate for timing chain slack. Then rotate clockwise until you reach 0.050 inch. This is 0.050 inch before max lift.

Note the reading on the degree wheel. Then continue over the nose of the cam until you reach 0.050 inch again. This is the 0.050 inch after max lift. Note the degree wheel reading again. Now add the two readings together and divide by 2 to find the center line. It should match the cam card.

For example, if your numbers are 80 and 132:

$$(80 + 132) \div 2 = 106\text{-degree centerline}$$

The cam card indicates the correct installed intake centerline. If it calls for 106 degrees and you come up with 108 degrees, the cam is early and you have to retard it 2 degrees to bring it into spec. If you get 104 degrees the cam is retarded and you have to advance it 2 degrees to correct it. If you have degreed the cam with the intake centerline method, go back and check to see if the intake opening and closing points match those indicated on the cam card. If incorrect, determine the direction of error and reposition the cam accordingly.

Calculating Valve Overlap

Overlap is the number of degrees where both valves are off their seats at the same time. It is a combination of the intake opening event and the exhaust closing event. Adding these two points together yields valve overlap.

$$\text{Valve Overlap} = \text{IO} + \text{EC}$$

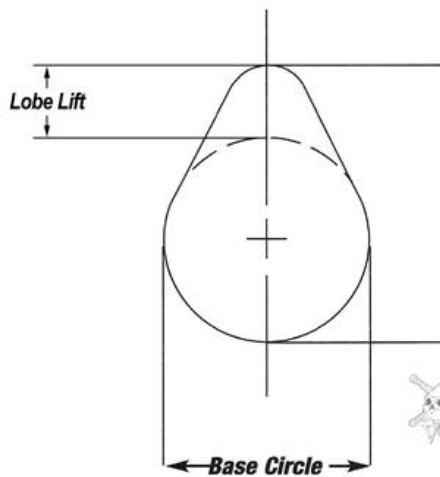
For example, a cam with an intake opening point of 29-degrees BTDC and an exhaust closing point of 23-degrees ATDC has a valve overlap of 52 degrees.

$$29 \text{ degrees} + 23 \text{ degrees} = 52 \text{ degrees overlap}$$

VALVE LIFT

The first line of a label will list the part number of the camshaft, followed by a term known as *Valve Lift*. This is very easily explained as the amount of travel by the lifter from the *zero location* on the camshaft up to the nose of the cam lobe.

Race engine builder Chuck Lawrence says that, “Knowing the amount of valve lift conveys many important spring requirements. The valve lift figure, for example, determines how tall the spring needs to be to enable it to open fully without becoming coil bound. It is also important to ensure the bottom of the spring retainer does not make contact with the valve stem seal or the valve guide. Further, the key to selecting optimum spring pressures is to find the lightest pressure that will close the valve, keep it closed, and not allow it to chatter on the valve seat. Of course, over a period of time valve springs lose their strength, so to avoid seat chatter we regularly check them and replace them when necessary.”

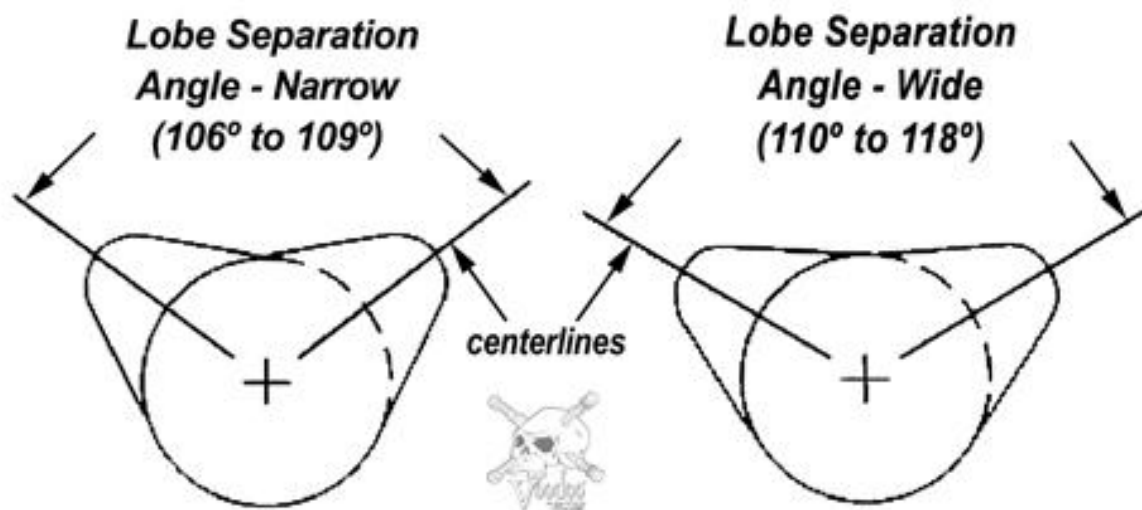


Lobe Lift: Subtracting the base circle dimension from the base circle and lobe lift dimension equals lobe lift.

LOBE LIFT

Lobe lift and rocker ratio are a function of valve lift. However, lobe lift is simply a measurement of the lobe's overall dimension from the heel to the toe minus the base circle dimension. That measurement multiplied by the rocker arm ratio generates the total valve lift figure.

Consider a lobe lift dimension of .312in and multiply it by 1.7 (a common LS rocker ratio) and the resulting valve lift will compute to .531in. Rocker ratios for an LS version engine are available from various manufacturers in ratios from 1.65:1 to 1.9:1. Changing the ratio will affect the overall valve lift and in some cases can cause clearance issues between the valve and piston. In addition, the greater the lobe lifts, the greater distance the tappet travels within its bore and, as a result, the greater it is affected by wear and tear. Often engine builders will select a camshaft with moderate lobe lift and increase the rocker ratio to gain extra valve lift.

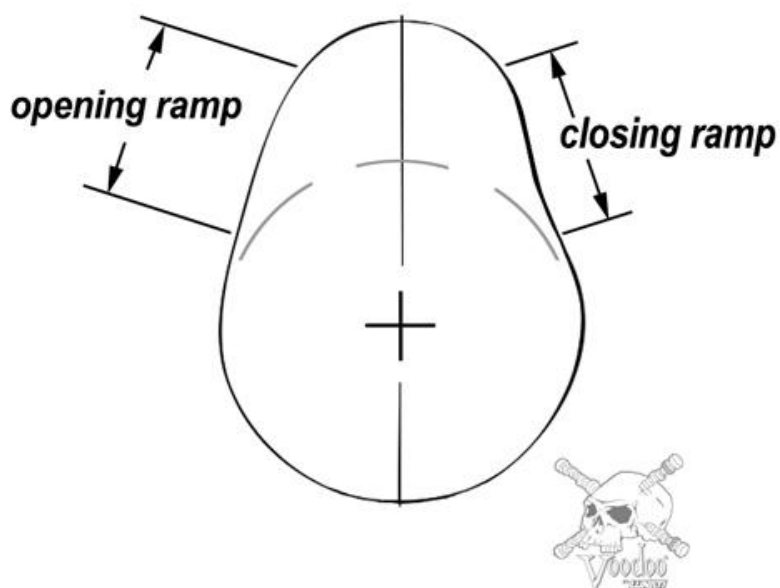


$$\text{Lobe separation angle} = \text{intake centerline} + \text{exhaust centerline} / 2$$

Lobe Separation: The lobe separation angle (LSA) is defined by the number of degrees that separate the peak lift point of the exhaust lobe and the peak lift point of the intake lobe (the center lines). LSA can be measured using a dial gauge indicator and a degree wheel, but is usually calculated by dividing the sum of the intake centerline and the exhaust centerline by two.

Lobe separation angle affects valve overlap, which occurs around Top Dead Center and is measured by the number of degrees of crankshaft rotation when both valves are open. Valve overlap affects the nature of the power curve, idle quality, and idle vacuum. A narrower lobe separation angle results in more valve overlap and is often recommended for naturally aspirated vehicles. A wider lobe separation angle reduces valve overlap and is usually recommended for forced-induction vehicles.

A curious and beneficial effect of a well-timed valve overlap is that it creates a scavenging in the combustion chamber. The rush of spent gases exiting the exhaust port instantly and decisively draws the fresh charge into the chamber through the intake port.



Symmetrical and Asymmetrical Lobe Designs

(CamProfile): With symmetrical design the profile of the closing ramp is a mirror image of the opening ramp. For decades symmetrically designed lobes were the standard of the camshaft industry. Then asymmetrical software

appeared that allowed camshaft designers to create a high velocity opening ramp profile and a slower velocity closing ramp profile. The chief advantages of the asymmetrical lobe design are rapid valve opening and, probably more important, slower valve closing that protects the valve train from abuse and premature wear and ensures its longevity.

The opening and closing ramp section of the camshaft lobe is the area between the base circle and the lobe peak. Often referred to as the ramp angle of the camshaft lobe, the more aggressive the lobe ramp, the faster the valve opens and closes.

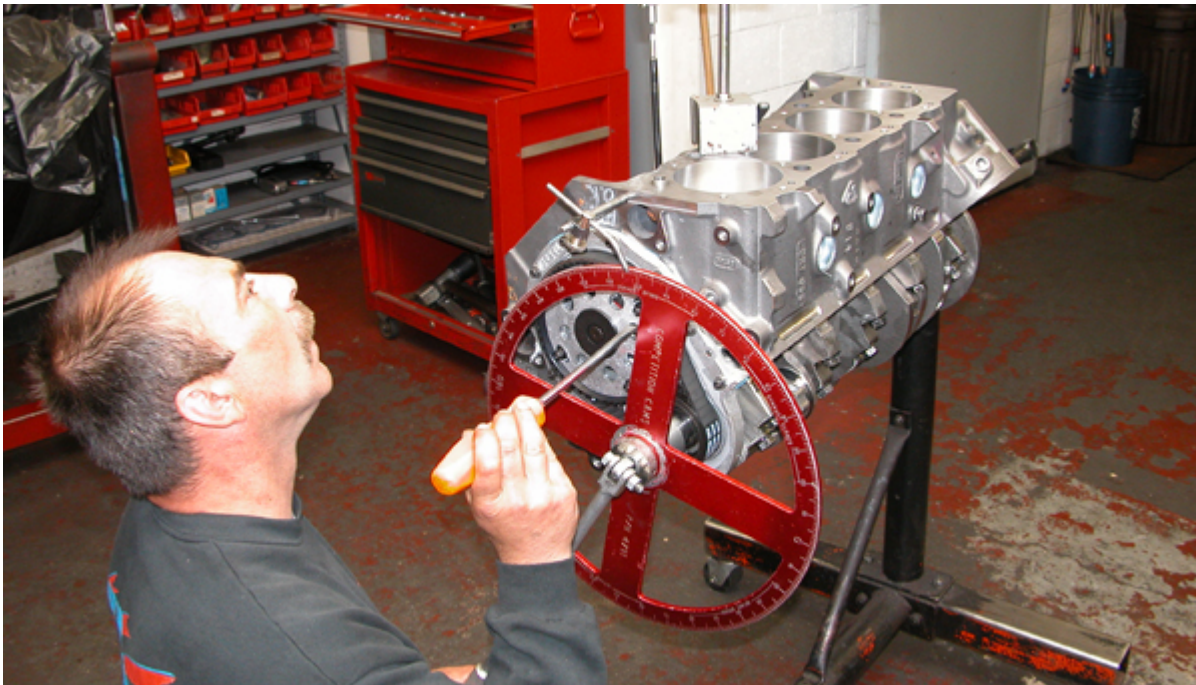
ADV DUR

Expressed in those short six letters is the term *Advertised Duration*, though it isn't very commonly used as a reference in the industry. It merely indicates a measurement of lobe duration from valve seat-to-seat. When thought of in those terms, it can have a varied effect in exactly how the measurement is taken. Lunati measures their advertised duration of hydraulic camshafts at .006in of valve lift off the seat. The advertised duration of a solid lifter camshaft is measured at .020in, which does not exactly give you an ability to compare one camshaft to another. The more common number is the measurement of duration at .050in of lobe lift.

DUR @ .050"

In contrast to *Advertised Duration*, the term *Duration at .050in* (tappet lift) is very common and used exclusively by engine builders and manufacturers as an ability to compare one camshaft with another.

Duration at .050in is measured with the use of a degree wheel and dial gauge indicator on the tappet, as Jeff Sams of Lunati explains, "First rotate the engine clockwise until the tappet is raised to .050in on the dial gauge indicator and mark your degree wheel. Holding slight tension on your camshaft to eliminate slack in the chain, continue to rotate the engine in the normal rotation until the lifter rises all the way up and then all the way down to .050in (from valve closed position). Next read the number on the degree wheel and total the amount of degrees of rotation, which will represent your duration at .050in"



VALVE LASH

Valve lash is the mechanical clearance in valve trains with solid flat tappets or solid roller tappets. It is measured between the valve stem tip and the underside of the rocker arm when the valve is closed, and usually while the engine is at operating temperature.

“Valve lash requirements can change depending on the design of the lobe profile,” Sams says. “The proper amount of lash ensures the valve closes completely and also prevents damage to the valve train when the valve opens. Lash settings can be adjusted a certain amount and used to fine tune the engine’s performance. Tighter lash opens the valve sooner and closes it later while looser lash does the opposite. When used to fine tune, lash has the same effect as a bigger or smaller camshaft. It’s important to note, though, that the cam manufacturer should be consulted before varying from the recommended specification.”

Because valve lash is meant to be adjusted when the lifter is resting on the base circle of the cam lobe, an easy way to determine this is to slightly crack open the exhaust valve and adjust the intake rocker. Rotate the engine in its normal rotation until the intake valve is almost closed and then proceed to adjust the exhaust rocker.

CENTER LINE

The term *Center Line* refers to the point of peak lift of a camshaft lobe in relation to top dead center (TDC) of the piston as measured in crankshaft degrees.

Sams says that, “The center line of a camshaft is based on the timing events best suited for a given application.”

Mark McKeown of MME Racing says, “Advancing the cam’s center line moves the torque curve lower or sooner in the rpm range. Retarding it moves the torque curve higher or later in the rpm range. It is often misunderstood that advancing makes more torque and retarding makes more hp. Peak torque is rarely affected, it just occurs at a lower or higher rpm. But when torque occurs at higher rpm, it does create a horsepower gain.”



Camshafts can sometimes resemble pieces of art, but all those bumps and journals are not merely there for show. Each lobe has gone through quite a bit of research before it is ground to perfection using state-of-the-art grinding equipment.

TIMING AT .050" TAPPET LIFT

The final rows of data on the box display valve timing data at .050in tappet lift, providing the cam was installed with the intake center line at 109 as prescribed by the manufacturer.

A COUPLE OF OTHER CAMSHAFT TERMS

Lobe separation is the number of crankshaft degrees between the intake and exhaust lobe centerlines.

The opening and closing ramp section of the camshaft lobe is the area between the base circle and the lobe peak. Often referred to as the ramp angle of the camshaft lobe, the more aggressive the lobe ramp, the faster the valve opens and closes.

Single and dual pattern camshafts are merely relating to an intake and exhaust profile that is or is not the same. Today's manufacturers work closely with their customers to design a camshaft that matches air flow characteristics, which in most cases requires a dual-pattern lobe design.

Symmetrical or asymmetrical camshaft lobes are another design feature. When the intake or exhaust lobe profile is the same in opening and closing speed, this is a symmetrical camshaft. When the lobe profile has a different opening and closing ramp, this is an asymmetrical camshaft.

SOURCES

Jon Kaase Racing Engines
Winder, Georgia
(770) 307-0241
www.JonKaaseRacingEngines.com

Lunati
Olive Branch, MS
662-892-1500
www.lunatipower.com

MME Racing
Waldorf, Maryland
(301) 932-9292
www.MMERacing.com

Clearly, journal diameters refer to the diameter of the camshaft journals which ride on the bearings in the cylinder block. Today's LS engines utilize 55mm bearing journals. Yet, it has become common practice on high horsepower engines to increase the bearing journal diameter. This allows for a stronger cam core as well as better cam profiles due to the larger size.

Like most other things, knowledge is power and a little understanding of camshaft terminology can go a long way toward assisting you in your search for faster and quicker. 