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ABOUT THIS CHAPTER

This chapter is about removing and installing press-fit crank arms, as well as installing replacement crank arms. Press-fit crank arms are made in square and splined configurations. Shimano XTR (FC-M960) cranks are also covered. The **COTTERED CRANK ARMS** chapter covers cottered crank arms. The **ONE-PIECE & BMX CRANKS** chapter covers one-piece crank arms. There is also a **CHAINRINGS** chapter, which should be referred to if the chainrings will be removed, replaced, or secured. The chapter **PEDAL REMOVAL, REPLACEMENT, AND INSTALLATION** includes information about pedal removal and installation—a job that is often done as part of crank-arm removal and installation.
GENERAL INFORMATION

TERMINOLOGY

Chainrings: The gears attached to the right crank arm that drive the chain when pedaling.

Chainring-mounting arms: The arms (usually five) that go from the end of the crank arm out to the chainrings. The chainrings are attached to the end of the chainring-mounting arms, which are also called spider arms.

Cotterless crank: Obsolete and is rarely used in regard to press-fit crank arms. In this manual, the type of crank arm that is referred to by the term cotterless crank is called a square-fit crank.

Crank arm: The lever arm that attaches to the bottom-bracket spindle at one end and the pedal at the other end. The right crank arm has chainring(s) (gears) attached to it, usually by means of chainring-mounting arms.

Crank-arm extractor: The tool used for removal of the crank arm from the bottom-bracket spindle.

Extractor body: The portion of the crank-arm extractor that threads directly into the crank arm.

Extractor shaft: The portion of the crank-arm extractor that threads into the extractor body and pushes against the end of the bottom-bracket spindle.

Extractor threads: These are the threads in the crank arm into which the crank-arm extractor threads.

Press-fit crank: A crank design that has a tapered hole in the crank arm that is pressed onto a tapered bottom-bracket spindle. The hole and spindle end may be a square or a spline.
**Self extractor:** A mechanism installed in a crank arm that permits extraction of the press-fit arm without the use of a crank-arm extractor.

**Splined-fit crank:** A crank design that has a splined hole in the crank arm that is pressed onto a tapered, splined bottom-bracket spindle. Due to the shallow angle of the taper, the taper is often overlooked and consequently is rarely included in the description. May be shortened to *spline crank*. Splined-fit crank arms that have no taper do exist and are characterized by a split in the spline hole which is closed down by a binder bolt (see figure 20-1a).

**Square-fit crank:** A crank design that has a tapered, square hole in the crank arm that is pressed onto a tapered, square bottom-bracket spindle. May be seen also as *square-hole crank*, *square crank*, *square-taper crank*, or *tapered crank*. Historically, this design has been called a *cotterless crank*, but this term is now rarely used (see figure 20-1b).
**PREREQUISITES**

**Pedal removal and installation**

Before removing a crank arm, the pedal should be removed. Pedals are much easier to remove with the crank arm still attached to the bike. If removing the crank arm(s) for simple maintenance (cleaning) or bottom-bracket service, pedal removal is optional. Although it may not appear so, pedal removal is generally not required for chainring removal; although, this is something that may be done to the crank arm once it is off. See the *Pedal removal, replacement, and installation* chapter for pedal removal and pedal installation.

**Chainring removal and installation**

If replacing a right crank arm, chainring removal will be required. For anything else, chainring removal is strictly optional. It is easier to do a thorough job of cleaning the crank arms and chainrings with the chainrings removed. See the *Chainrings* chapter for chainring removal and chainring installation.

**Front-derailleur adjustment and replacement**

If replacing a right crank arm with a non-identical one, the new one may position the chainrings slightly further in or out, requiring additional adjustment of the derailleur’s limit screws and cable tension. If replacing the right crank-arm/chainring assembly with an identical arm but a larger or smaller chainring, then the front-derailleur height must be changed. When changing the height of the front derailleur, the derailleur’s rotational adjustment may also change, which in turn may affect limit screws and cable tension. See the *Front Derailleurs* chapter for front-derailleur adjustment.
Front derailleur replacement is only required in two cases: if installing a new crankset or right crank arm with chainrings that have less than an 8-tooth difference between the largest ring and the next smaller one; or when the front derailleur was designed for a triple chainring with a 10-tooth or more difference. See the FRONT DERAILLEURS chapter to tell how front derailleur maximum chainring-size difference or minimum chainring-size difference has been exceeded. If installing a “micro-drive,” Shimano “compact drive,” or other crankset with reduced-size chainrings, there could be other problems with front derailleur capacity.

**Chainline error**

If replacing a right crank arm with one that is not identical, the chainrings may end up further in or out. While this might be acceptable in terms of chainring-to-frame clearance and/or front derailleur range of motion, it might change the chainline alignment. This alignment affects front derailleur performance, drive-train noise, and drive-train wear. Only by knowing how well the chainrings aligned originally, and combining that information with how much further in or out the chainrings will end up relative to the frame, can you determine whether the new crank arm is acceptable for use with the existing bottom-bracket spindle.
**Rear derailleur replacement**

In the case of installing a new crankset or a new right arm with different-size chainrings than the original ones, it is possible to exceed the capacity of the rear derailleur to eliminate the chain slack when the chain is in the smallest chainring and smallest rear cog. It is the difference in number of teeth between the smallest and largest chainring that is important, not the absolute size of either chainring. See the **REAR DERAILLEURS** chapter to determine if the *capacity* matches the new chainring set.
INDICATIONS

**Maintenance cycles**

If properly installed, crank arms should not need any routine maintenance. Other books and periodicals recommend routine tightening of crank-arm mounting nuts/bolts. This would only be necessary if they were under-tightened initially. Routine tightening of the nuts/bolts without using a torque wrench to make sure that they are not being over-tightened invites damage to the arm from over-tightening.

**New bikes**

If assembling a new bike, removing and reinstalling the crank arms is recommended. This is the only way to know that the mounting surfaces are properly prepared and the torque is correct. It is an unfortunately common problem with new bikes that the crank arms work loose and are destroyed. Although this would be covered by warranty, it would be nicer to avoid it altogether.

**Bottom-bracket service**

To adjust, overhaul, or replace the bottom bracket, crank-arm removal is required. There may be no apparent problems with the crank arms, but this is an excellent opportunity to check for potential problems.
Symptoms indicating loose arms

One of the most persistent problems with crank arms is that they work loose. This can strand the rider, and it can easily destroy the arm that works loose—an expensive concern. Creaking noises from the crank area are a warning sign that the arms may be loosening, but loose pedal parts and loose chainring bolts can cause similar noises, so check all these areas at the same time. When the arm makes a knocking sound or feels loose while pedaling, the situation is critical. If it is not too late, it may be possible to save the arm by not pedaling on it until it can be secured. Pedaling lightly, for even one block, may destroy the arm.

With proper installation, most riders do not need to periodically tighten the crank arms. Other books and magazine articles often state “re-tighten crank arms every 100 miles,” or something similar. The crank arm would be the most under-designed part on the bicycle if this was the case, and bike shops would be selling as many replacement crank arms as they do inner tubes. In fact, it is possible to damage crank arms from routine tightening without a torque wrench, which is why it is not recommended. With a torque wrench, crank arms can be regularly checked without risk. If they are remaining tight (as they should), then the torque wrench will show this without adding any tightness. If they have worked loose, the torque wrench will tighten them back to the original torque. If they work loose more than once, consider a higher torque. This “torque checking” (as opposed to periodic re-tightening) is an excellent form of preventive maintenance.
**Symptoms indicating damaged arms**

When the normal installation techniques (plus using the maximum recommended torque) fail to keep the arm secure, it means the tapered square hole in the arm is deformed (enlarged or distorted). The crank arm should be replaced.

**Symptoms indicating bent arms**

Crank arms bend sometimes when the bike is crashed, and they can bend from abusive jumping. The symptom of a bent crank arm is an oscillating sensation felt in the ankle while pedaling. This oscillation may feel like a twisting back and forth on the ball of the foot or like the outer edge of the foot is rocking up and down, or it may feel like both at once. The identical symptoms are caused by bent pedal shafts, which can easily be damaged by the same forces that damage crank arms. Depending on the relative strength of the crank arm or pedal shaft, either may be more likely to bend. The first step is to remove the pedal and look at the end of the shaft as it rotates. If the end does not oscillate, then it is the crank arm that is bent. If it does oscillate, new pedals are needed. If the symptom is still felt when riding with new pedals, then the arm is also bent.

**Symptoms indicating damaged pedal-mounting threads**

Pedal-mounting threads can be damaged from improper pedal installation. The only symptom is difficulty threading in the pedal. Sometimes it is repairable, which is described in the chapter PEDAL REMOVAL, REPLACEMENT, AND INSTALLATION, but sometimes it is necessary to replace the crank arm.
Symptoms indicating damaged crank-arm-removal threads

The crank-arm-removal tool threads into the crank arm where the bolt/nut dustcap comes out. Damage to these threads will be indicated by difficulty threading in the crank extractor or by the extractor pulling out of the crank-arm threads when attempting a crank-arm removal. These threads can be damaged from failure to protect them with the bolt/nut dustcap, improper removal tool use, or failure during removal due to over-tight arm installation. In some cases, this thread damage may be repairable, but in most cases it is not. When the threads are damaged beyond repair, the arm should be replaced. There is a section at the end of this chapter on repair of these threads and how to remove the arm when the threads are unrepairable.

Symptoms indicating cracked arms

Crank arms can crack in a number of places. Sometimes a crack will develop between the pedal mounting hole and the end of the arm. Sometimes a crack will develop at the crotch of the chainring-mounting arms (spider arms) and the crank arm. Sometimes a crack will develop between a corner of the tapered square hole and the mounting end of the arm. These cracks may make themselves known through creaking noises, but that is not likely. Most likely, the cracks will be discovered through inspection. Whenever servicing the crank arms (especially when cleaning), inspect in all these areas for cracks. If the arm cracks and is not replaced, it can result in a catastrophic failure, which can lead to serious injury.
TOOL CHOICES

The design or brand of crank arm and spindle will determine the tools needed.

Table 20-1 covers all tools for the job. The preferred choices are in **bold**. A tool is preferred because of a balance among ease of use, quality, versatility, and economy. When more than one tool for one function is in **bold**, it means that several tools are required for different configurations of parts.

Although some distributors sell special pullers for removing crank arms with stripped threads, none of these tools are listed here because the best techniques for doing the job do not require any special tools.
TIME AND DIFFICULTY RATING

Crank-arm removal and reinstallation is a 1–2 minute-per-arm job of little difficulty. Fitting a new replacement crank arm, which can include chainring and pedal removal and installation, as well as front-derailleur adjustment, is a 10–45 minute job of little difficulty (unless derailleur adjustment is included, in which case difficulty may be high).
COMPLICATIONS

DUSTCAP WILL NOT UNTHEARD

Cross-threading or corrosion can turn the relatively simple task of removing a crank-arm dustcap into an ordeal. The tool-fitting in the dustcap usually strips out. The best solution is to drill two holes in the face of the dustcap and use an adjustable pin spanner to get it out. Some plastic threaded dustcaps with this problem will just rip apart instead of unthreading. In this case, there is no choice except to use some sort of pick or pry tool to dig out the remaining pieces bit by bit.

EXTRACTOR WILL NOT THREAD INTO ARM

Never force the extractor in! The first thing to check when the extractor will not thread in is whether the bolt/nut has actually been removed. Next, try more carefully to keep the axis of the extractor aligned with the axis of the spindle rather than perpendicular to the face of the crank arm. If this does not solve the problem, then the threads are probably mangled. There is a section at the end of the chapter about repairing mangled threads.

THREADS ARE STRIPPED OUT IN ARM

If the threads are stripped out before crank-arm removal is attempted, then it is simply a matter of removing and replacing the arm (procedure at end of this chapter). If they strip while attempting removal, it is important to determine why. If correct removal technique has been used, then the failure has occurred because the arm was too tight. This is not unusual. The responsibility lies with the last person to install the arm. If there is not 100% certainty that the removal technique was correct, then the shop owes the customer a replacement arm.
**Chainrings wobble excessively with crank in all four mounting positions**

Lack of precision with the flats of a square-taper spindle and with the square hole in the arm can effect the amount of chainring wobble that occurs in each of the four possible positions in which the arm can be mounted on a spindle. If the wobble is unacceptable in the best of these four positions, then the problem is with the chainring-mounting arms or the chainrings themselves and not with the crank-arm/spindle fit. **Misaligned chainring-mounting arms** and **misaligned chainrings** are addressed in the **CHAINRINGS** chapter.

**Replacement arm does not fit spindle**

It is not unusual for one brand of crank arm not to fit another brand’s spindle. Sometimes there are even compatibility problems between different models or years of the same brand. Many older European-brand crank arms cannot be used with most spindles manufactured in Asia. New Shimano crank arms cannot be used with anything but new Shimano spindles. The removal and installation procedures in this chapter include inspections to determine whether an arm and spindle are compatible. Unfortunately, it is not practical to create a table of compatibility for the huge and ever-changing selections of spindles and crank arms.

**Replacement arm changes chainring clearance**

A non-identical replacement of the right-side crank arm may fit the spindle but not necessarily put the chainrings in the same position relative to the frame. If the chainrings end up closer to the frame, it could be a problem. The following procedures have steps for checking the original clearance and the clearance after installing a new right arm.
Replacement arm changes chainline

Because a replacement right-side arm can change the chainring positions, it can change the alignment of the chainrings to the rear cogs (chainline). The following procedures have steps for checking chainline before and after, but the separate Chainline chapter should be referred to for help in how to measure chainline and how to identify whether an error is significant.

New chainring size/position changes front-derailleur adjustment

If installing a replacement right-side crank arm, the chainrings may move in or out. This would necessitate changing both limit screws and the cable setting on the front derailleur. If the replacement crank arm has a large chainring of a different size, then derailleur height and rotation would need to be reset (which leads to limit-screw and cable adjustment as well).
ABOUT THE REST OF THIS CHAPTER

The rest of this chapter is divided into five parts. The first part is procedures for square-fit crank arms. The second part is procedures for spline-fit crank arms. Both the first and second parts refer to another chapter for replacing chainring, which is something that might be done while the crank arms are removed. The third part is procedures for removing crank arms with damaged extractor threads. The fourth part is procedures for Shimano XTR split-spline cranksets (model FC-M960). The final section is crank-arm troubleshooting.
SQUARE-FIT CRANK ARMS

IF REPLACING ARM(S) OR TO FACILITATE CLEANING
1. Optionally, remove pedal(s). See PEDAL REMOVAL procedure.
PREPARATION AND PRE-REMOVAL INSPECTIONS

In the next step, measure the clearance between the right-crank assembly and the chain stay (see figure 20.2). The chain stay is the frame tube that runs from the bottom bracket to the rear dropout. If the bike has raised chain stays (they connect to the seat tube above the front derailleur) or rear-suspension arms or links positioned completely above the chain, measure to the side of the seat tube instead. The measurement is useful, even if just reinstalling the same crank arm, for two reasons.

First, due to frame flex and chainring flex, there must be at least 2mm clearance between every part of the right-crank assembly and the frame. Otherwise, frame damage may occur while the bike is being ridden. Measuring before removal reveals a significant problem or borderline problem, before going to the trouble of reinstalling the arm. If clearance is poor before removal, it will be necessary to check and replace a worn-out arm or put in a longer bottom-bracket spindle if the arm is fine. If the clearance is marginal before removal, measuring will alert you to a potential problem when the arm is reinstalled. Second, after reinstalling the original arm or installing a replacement arm, measuring the change in the clearance reveals whether it will be necessary to re-adjust the front derailleur.

2. Measure clearance between chain stay and part of right crank that comes closest to chain stay (usually inner chainring or bolt heads holding on inner chainring but occasionally another chainring; see figure 20.2). Enter measurement here: mm

NOTE: If rear stays or suspension arms are in a position where chainring rub is not an issue, measure clearance to a main frame member.
In the next step, measure the chainline error. Chainline is the alignment of the front gears to the rear gears and is covered extensively in the **CHAINLINE** chapter. It affects drive-train noise and shift performance (see symptoms). Measure it before making any changes and then again after reinstalling the original right arm or a new right arm so it will be known whether chainline ended up worse, in which case it would be necessary to check for symptoms in order to determine whether the error was significant.

3. Measure chainline error, record here:

   **mm**

   Chainrings  **out (+) or in (-)**  (check one)

   Step #4 has two alternate procedures. One is for cranks that require a crank extractor, and the other is for cranks that have a self-extractor mechanism. The distinguishing features of self-extractor mechanisms are that there is a ring around the crank bolt with a hole in the center (through which the crank-bolt head can be seen) and the ring has pin holes or slots for the engagement of a tool. If both features are not evident, the crank arm is not self extracting. When steps throughout this procedure have variations due to these two designs, the variations are labeled **standard only** or **self extractor only**.

   **NOTE: Since most steps in this procedure must be done once for one arm and again for the second arm, double checkboxes are provided to facilitate tracking of your progress. These double checkboxes are optional and do not affect the outcome of any automated processes of this program.**
4. **Standard only:** Remove dust cap if bolt head is hidden. Cap may be pressed into or threaded into crank-arm face.

**Self extractor only:** Check that ring is fully engaged (rarely, ring may be left-hand thread).

*NOTE:* Ring should not be tightened—removal will be difficult! If ring is not fully engaged, watch carefully during step 5 for ring unthreading further while loosening bolt!

If the bolt being removed in step #5 is a hex-socket bolt, then there is a possibility that the crank arm is self-extracting. In this case, the arm will come off as the bolt is loosened, and the arm and bolt will stay together as a unit. If this is the case, watch closely for the ring around the bolt head unthreading as the bolt is loosened.

5. **Standard only:** Remove bolt or nut, then look closely for washer that may be in crank arm. Remove washer, if any.

**Self extractor only:** Break loose bolt (bolt torque is being released), continue to unthread bolt, then break loose bolt again (press fit is being released). *NOTE:* Hold on to arm while threading bolt out fully so arm will not fall off spindle.

*NOTE:* Self extractor only, steps 6–10 do not apply. Go to step 11.
In the next step, check for evidence that the crank arm is worn out or was originally a poor fit to the spindle. After removing the nut or bolt/washer, a square hole in the crank arm should become visible (this is where the spindle is inserted). If the end of the square portion of the spindle is recessed inside the square hole of the crank arm by any amount, then the fit is most likely acceptable. If the square end of the spindle fills up the entire depth of the square hole in the crank arm, then the fit is unacceptable. In this latter case, the nut or bolt that secures the crank arm will be stopped by the end of the spindle before it has pushed the crank arm far enough on to secure it. The resulting symptoms would be creaking sounds and repetitive loosening of the arm.

6. **After removing bolt/nut, inspect if spindle fills square hole (should not, see figure 20.3). Check one choice for each arm removed:**
   - Right arm  OK  not OK  (check one)
   - Left arm  OK  not OK  (check one)

   **NOTE: If not OK, arm(s) must be replaced.**
CRANK-ARM REMOVAL AND INSPECTION

In the following steps, a crank-arm extractor is installed and a crank arm removed. This is a very critical procedure. If done improperly, the crank arm or the spindle can be destroyed. See table 20-1 to select an appropriate extractor. It is critical that the extractor is compatible with the thread of the crank arm and with the shape of the end of the spindle. If using one of the recommended tools, simply follow the guidelines indicated in the table.

If using an existing extractor and it is not one of the models listed in the table, consider these factors. Thread compatibility is not an issue unless the crank arms are one of the following brands/models: T.A. (all models), Stronglight (models retained by a 16mm bolt only), Viscount (all models), Lambert (all models), or Campagnolo (C-Record models). Viscount and Lambert removers are no longer available. For removers that are a compatible-thread type for the other brands, see table 20-1. All other cranks have the common 22 × 1mm thread. The other important factor is whether the spindle is a nut-type or bolt-type. Many different brands of extractors are compatible with each of these spindle types. If the tip of the extractor shaft is approximately 12mm diameter, it is designed for use with spindles that accept a bolt to retain the crank arm. If the tip of the extractor shaft is approximately 10mm diameter, it is designed for use with spindles that accept a nut to retain the crank arm. Use of the wrong extractor type may destroy the crank arm or the spindle! The Park CCP-2, CWP-5 and CWP-6 are the only common tools that are compatible with both spindle types (see figure 20.4). The CWP-6 replaces the CWP-5, which is no longer made.
When threading the extractor into the crank arm, it should go in easily using just fingers (see figure 20.5). If the extractor does not thread in easily, it may be cross-threading or the threads may be damaged. To avoid cross-threading, align the shaft of the extractor in line with the spindle axis rather than perpendicular to the face of the crank arm. If the threads are damaged, move ahead to the section of this chapter titled **REMOVING CRANK ARMS WITH DAMAGED EXTRACTOR THREADS**.

In step #7, the extractor is secured in the arm with a wrench. There is no particular torque and not a lot of force is required. The purpose is simply to ensure that the extractor is fully installed instead of just hanging up on a rough thread. If it is installed fully and it begins to rotate further during arm removal, stop the procedure before unrecoverable damage occurs.

7. Thread extractor into crank arm with fingers and snug with wrench.

A common mistake is to fail to install the extractor all the way in because the extractor shaft bottoms against the spindle before the extractor is fully threaded into the crank arm. Step #8 is a safety check so that this does not happen. If everything is set up right when the extractor body is secured with a wrench, it should still be possible to turn the extractor shaft either way with fingers (see figure 20.6). If the extractor shaft cannot be turned with fingers, the shaft is engaging the spindle before the extractor body is fully engaged in the crank-arm threads. When there is poor thread engagement, crank-arm-thread failure is likely to occur.
8. Check with fingers whether extractor shaft turns and check one of following choices (see figure 20.6):
   Shaft is tight, loosen it further and re-snug extractor into crank.
   Shaft is loose, ready for arm removal.

   In step #9, tighten the extractor shaft to remove the crank arm. At this point in the procedure, there is still a possibility of removal failure and damage to the crank arm. If the correct warning signs are looked for during arm removal, it may be possible to detect a failure before the damage gets critical, solve the cause of the problem, and then successfully remove the arm. While tightening the extractor shaft, simultaneously watch for either of the following warning signs. First, if the extractor body starts to rotate, the crank-arm extractor-threads may be stripping. Second, if the extractor appears to begin pulling out of the arm (or starts cocking to one side in the arm), the crank-arm extractor-threads may be pulling out. In both cases, immediately stop tightening the extractor shaft and remove the extractor from the arm. Inspect for a nut, bolt, or washer that was not removed. Inspect thread compatibility of the extractor to the crank arm and inspect for compatibility of the extractor type with the spindle type. If no problems are found, then the only problem might be that the arm is seized to the spindle. Flood the hole with penetrating oil and attempt removal again.

9. Tighten extractor shaft to remove crank arm (see figure 20.7).
10. With arm still on spindle but loose, break loose extractor from crank arm.
Step #11 has a function for standard and self-extracting crank arms and an additional function just for self-extracting crank arms. The common function is to inspect the spindle flats and crank-arm square hole for evidence that the arm is damaged or incompatible with the spindle. Self-extracting arms should have the self extractor removed so that it can be properly setup and so the square-hole inspection can be done.

The inspection for damage and incompatibility has two components. Crank arms invariably leave marks on spindle flats (see figure 20.8). As long as these marks do not extend all the way to the inner end of the flats, the crank-arm fit is acceptable. If the marks cover the full length of the spindle flats, the arm is worn out or has always had a bad fit to the spindle. If the crank arm presses all the way onto the spindle, then the arm is bottoming against the fat part of the spindle at the end of the flats instead of the taper firmly wedging inside the square hole of the arm. This will result in creaking and ultimately in repetitive loosening of the crank arm. When this evidence exists on the spindle flats, it indicates there may be damage in the square hole of the crank arm. The end of the square hole on the inward face of the arm should be a clean, square, shape and the edges of the hole should be sharp and distinct, not be flared, rounded, or deformed. When the marks on the spindle indicate possible damage but the square holes look good, it means a damaged or poor-fitting arm has been replaced; the condition of the inward end of the square hole is the final determining factor.
11. **Standard only:** Inspect marks on spindle flats (see figure 20.8) and circle one choice for each arm removed, then inspect square hole on inner face of arm(s) if “not OK” choice is checked:
Right arm: OK      not OK  (check one)
Left arm: OK      not OK  (check one)
*NOTE: If not OK, arm(s) must be replaced.*

**Self extractor only:** Unthread self-extractor ring, remove bolt and washer from threaded hole, remove anti-friction washer (brass or plastic) from inside face of ring or from bolt head, then inspect marks on spindle flats and circle one choice for each arm removed. Inspect square hole on inner face of arm(s) if “not OK” choice is checked:
Right arm: OK      not OK  (check one)
Left arm: OK      not OK  (check one)
*NOTE: If not OK, arm(s) must be replaced.*
12. Optional: Remove chainrings (see REMOVING CHAINRINGS).
CRANK-ARM CLEANING AND DAMAGE INSPECTION

13. Clean crank arms and chainrings (if any).

In step #14, inspect inside the square hole in the crank arm for damage. A normal hole will have four flat sides and maybe a burr on each flat where the end of the spindle flat stopped. When an arm is ridden while it is loose, the spindle rotates slightly inside the hole of the arm. This shows up as extra indentations on the edge of the hole (see figure 20.9).

Once this happens, the arm has a tendency to loosen up rapidly after proper installation. The best solution is to replace the arm. A temporary repair using Loctite RC680 (bearing supply houses) on the mating surfaces of the spindle and arm may be attempted, if the damage is not severe. Be aware that each time the damaged arm is removed and reinstalled a fresh application of RC680 is required.

14. Inspect inside square hole in each crank arm for deformed flats and circle one choice for each arm removed (see figure 20.9):
   Right arm    OK      not OK   (check one)
   Left arm     OK      not OK   (check one)

   NOTE: If not OK, arm(s) must be replaced.

15. Inspect arm for cracks originating at square hole in each crank arm and circle one choice for each arm removed:
   Right arm    OK      not OK   (check one)
   Left arm     OK      not OK   (check one)

   NOTE: If not OK, arm(s) must be replaced.
16. Inspect for cracks originating at pedal-mounting hole in each crank arm and circle one choice for each arm removed:
   Right arm  OK      not OK  (check one)
   Left arm  OK      not OK  (check one)
   NOTE: If not OK, arm(s) must be replaced.

17. Inspect right arm (if removed) for cracks at crotch of spider arms to crank arm.
   OK      not OK  (check one)
   NOTE: If not OK, arm must be replaced!
CRANK-ARM INSTALLATION

18. Install chainrings, if removed (see ASSEMBLY OF CHAINRINGS TO CRANK ARM).

NOTE: If reinstalling a single arm that was removed, skip to step 33.

In steps #19 through #31, install a right arm in all four possible positions in order to determine the position that results in the least chainring wobble. There is imprecision in both the fabrication of the spindle flats and in the fabrication of the square hole in the crank arm. In some combinations, the imprecision of each will add together to cause the chainrings to wobble unacceptably. In other combinations, the imprecision of each will cancel the other out, allowing the chainrings to run relatively true. This is why it is best to try mounting the crank arm in all four positions.

The above-mentioned technique requires that the arm be somewhat secured on the spindle. Of course, this could be done by securing the arm with the nut/bolt, checking the chainring wobble, removing the nut/bolt, and then using the extractor to remove the arm so that another position could be checked. This method is good, but time consuming. The method described in the following steps uses a soft hammer to strike the arm on and off, which saves considerable time and effort. If done properly, it is effective and does not damage any equipment. If unwilling to strike the crank arm with a soft hammer, then use normal mounting and removal procedures wherever the step suggests using a hammer.
**Installing a pair of crank arms**

19. Use a marker to mark one corner between two flats on right end of spindle. **NOTE: Standard configuration is with diagonal of square hole in arm in line with axis of arm. Occasionally arms have square holes rotated 45° from this, with flats of hole parallel to and perpendicular to axis of arm. In this case, mark a flat for this step, instead of a corner.**

20. Turn spindle so that mark is at 12:00.

21. Place right crank arm on spindle so that arm points to 6:00 and tap firmly on with rubber/plastic mallet (see figure 20.10).

In step #22 and some later steps, spin the crank and check chainring wobble. If the front derailleur is still mounted and the cable hooked up, the best way to check chainring wobble is to position the nose of the derailleur’s outer plate directly over the outer chainring. Sight down through the outer plate of the derailleur while spinning the crank and observe to what degree the chainring moves inside and outside of the nose of the derailleur’s outer plate.

If the front derailleur is not set up, use another method to check wobble. Brace a hand against a frame tube and position the tip of a finger lightly against the inside face of the teeth of the outer chainring. As the rings spin, see and feel the teeth move toward and away from the finger (see figure 20.11).

22. Check that crank arm is not loose on spindle and spin crank to check degree of outer-chainring wobble (check at teeth, see figure 20.11). **NOTE: In later steps, comparisons are made to amount of wobble seen in this step. No method of quantification is available—rely on making mental “video.”**

23. Tap on back of crank arm with rubber/plastic mallet to remove arm (see figure 20.12).
24. Rotate spindle so that mark is at 3:00 and place right crank arm on spindle so that arm points to 6:00. Tap firmly on with rubber/plastic mallet.
25. Check that crank arm is not loose on spindle and spin crank to check degree of chainring wobble. Check one of following choices: Better than previous check.
No better than previous check.
26. Tap on back of crank arm with rubber/plastic mallet to remove arm.
27. Rotate spindle so that mark is at 6:00 and place right crank arm on spindle so that arm points to 6:00. Tap firmly on with rubber/plastic mallet.
28. Check that crank arm is not loose on spindle and spin crank to check degree of chainring wobble. Check one of following choices: Better than both previous checks.
No better than both previous checks.
29. Tap on back of crank arm with rubber/plastic mallet to remove arm.
30. Rotate spindle so that mark is at 9:00 and place right crank arm on spindle so that arm points to 6:00. Tap firmly on with rubber/plastic mallet.
31. Check that crank arm is not loose on spindle and spin crank to check degree of chainring wobble. Check one of following choices: Better than all previous checks.
No better than all previous checks.
32. Tap on back of crank arm with rubber/plastic mallet to remove arm.
Rotate spindle to position that was set in whichever step number is checked here: step 25 step 28 step 31
NOTE: If step 25 step 28 and step 31 are ALL checked here, rotate spindle so mark is at 12:00.
In step #33, prepare the arm for installation by cleaning the mating surfaces of the spindle and arm with acetone or alcohol. The purpose of this is to remove any traces of lubricant. Since these two pieces are held together by friction, grease or oil may enable the arm to go on further (not necessarily a good idea). Further is not more secure if arrived at by using lubrication. Crank manufacturers are unanimous in recommending against lubrication of the spindle when mounting the arm. Arguments to the contrary have been voiced, but never lubricate the spindle flats! If there is a concern about preventing corrosion or about contaminants getting in the gaps between the spindle flats and the hole flats in the arm, then treat the mating surfaces with Loctite 222 or 242 (bearing-supply or automotive-supply stores). The Loctite will seal the surfaces from moisture or dirt, reduce creaking problems, will not cause the arms to be less secure, and will allow arm removal with normal effort.

**NOTE:** In step 33, the spindle is cleaned with solvent, which may remove the mark. Do not rotate spindle from position set in step 32 or steps 19–32 must be repeated!

33. Clean flats on spindle end and in crank-arm square hole with zero-residue solvent (such as alcohol).

34. Grease steel washer (if any), bolt or nut threads, and under bolt head or nut flange.

**NOTE:** Go to step 38 if one crank arm was removed and only one needs to be installed.

**Installing right arm**

35. Place right arm on spindle so arm is at 6:00 position.
36. Install washer (if any) and bolt or nut, then use either choice A or choice B below:
   A: Manufacturer’s maximum recommended torque (see table 20-2 or use manufacturer’s published recommendations) then check for ≥2mm clearance of chainrings to frame.
   B: In absence of manufacturer’s recommendations, torque to 350in-lbs, then check for ≥2mm clearance of chainrings to frame.
37. **Standard only**: Treat dustcap threads (if any) with Loctite 242 and gently secure (unthreaded dustcap, just press in).
   **Self extractor only**: Install anti-friction washer (if any) to bolt head, grease inside face of ring, treat ring threads with Loctite 242, then thread ring in fully. **DO NOT SNUG!**

**Installing second arm**
38. Place arm on spindle so that it points 180° away from already-installed arm.
39. Install washer (if any) and bolt or nut, then use either choice A or choice B below:
   A: Manufacturer’s maximum recommended torque (see table 20-2 or use manufacturer’s published recommendations) then check for ≥2mm clearance of chainrings to frame.
   B: In absence of manufacturer’s recommendations, torque to 350in-lbs, then check for ≥2mm clearance of chainrings to frame.
40. **Standard only**: Treat dustcap threads (if any) with Loctite 242 and gently secure (unthreaded dustcap, just press in).
   **Self extractor only**: Install anti-friction washer (if any) to bolt head, grease inside face of ring, treat ring threads with Loctite 242, then thread ring in fully. **DO NOT SNUG!**
CHECKING NEED FOR FRONT-DERAILLEUR ADJUSTMENT

41. Measure chainring-to-frame clearance (as in step 2):
   Original measurement transferred from step 2:
   Change in chainring clearance (if any):

   NOTE: If change value above is more than .2 or less than –.2, front-
   derailleur performance may change!

   NOTE: Skip to step 54 if arms installed are original arms removed (not
   replacements).
CHECKING FIT OF REPLACEMENT ARM

CHECKING CHAINRING FIT IF REPLACEMENT ARM IS A RIGHT ARM

If using old chainrings with a new crank arm, check the CHAINRINGS chapter to determine whether the new arm is compatible with the chainrings. However, chainring compatibility is not just a matter of whether the mounting holes in the chainrings and the crank arm match. With some chainrings, spacing between the two is critical and not universal.

In the next step, measure the chainring clearance. With the new arm installed, check the chainring position. Any change in clearance could represent a potential problem with shifting, chainline alignment, and frame clearance. Step #42 establishes whether the chainrings have changed position in a way that will cause a problem with frame clearances and whether they have changed position enough to require adjustment of the front derailleur. Step #43 and #44 establish whether any chainline error has worsened or improved.

Some bikes have raised chain stays (chain stays that are above the chainrings and do not overlap the chainrings) or rear-suspension arms/links that do not overlap the chainrings. In these cases, clearance between the chainrings and the frame is no longer an issue. However, change in chainring position still affect front-derailleur adjustment and chainline. With these bikes, clearance to the chain stays cannot be measured, so the distance between the chainrings and another frame part should be measured.
42. Measure chainring-to-chain-stay clearance (measure clearance to seat tube if bike has raised chain stays) and enter new clearance here: 

Original clearance from step 2 is transferred to here: 

Clearance change is: 

Check A, B, or C choice below:  
A: Clearance is ≥2mm (ignore for bikes with raised chain stays) and clearance is >.2mm different than number in step 2. *NOTE: Front derailleur limit screws and cable will need adjustment!  
B: Clearance is < 2mm. *NOTE: Replacement arm is unacceptable to use with existing spindle!  
C: Clearance is different by ≤.2mm from number in step 2. *NOTE: Front derailleur adjustment is not needed. Arm is a good fit.  

In the next two steps, measure the chainline after installing a new right crank arm to determine whether it has been changed enough to create or solve a problem. Don’t limit your focus to whether there is a measurable error, but include whether the error has changed enough *to introduce or eliminate chainline error symptoms. See *CHAINLINE chapter for information about how to measure chainline error and symptoms of chainline error.
43. Measure chainline error, record here: mm
   Chainrings out (+) or in (-) (check one)

44. Compare step 43 to step 3 results: mm (out in)
    Then, choose one of following choices:
    Error is equal to step 3. NOTE: Arm is acceptable if no chainline-
    error symptoms were experienced with original arm.
    Error is in the same direction but less than step 3. NOTE: Arm is
    acceptable unless previous chainline error was unacceptable and
    change is not enough to eliminate symptoms. Bike should be evalu-
    ated for chainline-error symptoms!
    Error is in new direction. NOTE: Bike should be evaluated for
    chainline-error symptoms.
    Error is in same direction but greater. NOTE: Bike should be eval-
    uated for chainline-error symptoms!

Checking fit of replacement arm(s)
NOTE: Perform steps 45–53 complete for one arm before doing 45–53
for a second arm.
When installing mismatched brands of arm and spindle or installing a used arm on a different spindle, it is important to check whether the arm and spindle are a compatible fit. The only practical way to check this is to remove the arms again and inspect the conditions found during and after removal. If everything is fine, then just reinstall the arms. To avoid having to re-find the best of four positions for the right arm, do not remove both arms at once.

45. Remove dust cap (if any) or remove self-extractor ring.
46. Remove nuts or bolts/washers.
47. Inspect crank-arm fit (spindle-end recessed or not to outer end of square hole) and circle one choice for each arm removed:
   Right arm  OK      not OK  (check one)
   Left arm   OK      not OK  (check one)
   **NOTE: If not OK, arm(s) must be replaced.**
48. Thread extractor into crank arm with fingers and snug with wrench.
49. Check with fingers whether extractor shaft turns and check one of following choices:
   Shaft is tight; loosen it further and re-snug extractor into crank.
   Shaft is loose; ready for arm removal.
50. Tighten extractor shaft to remove crank arm.
51. With arm still on spindle (but loose), break loose extractor from crank arm.
52. Inspect marks on spindle flats and circle one choice for each arm removed:
   Right arm  OK      not OK  (check one)
   Left arm   OK      not OK  (check one)
   **NOTE: If not OK, arm(s) must be replaced.**
53. Repeat steps 38–40 for each arm removed.
INSTALL PEDALS
54. Install pedal(s) if removed. See **PEDAL INSTALLATION** procedure.
**SPLINE-FIT CRANK ARMS**

**TYPES**

Two common spline configurations exist. These are the ISIS configuration and the Shimano Octalink configuration. The ISIS configuration is readily identified by its ten-spline count. The Shimano Octalink configuration is characterized by the presence of eight splines. Both configurations are made by a variety of manufacturers, so don’t rely on brand as a guideline to type.

There are two types of Octalink spline patterns used. The original pattern, found on Shimano XTR, Dura-Ace, Ultegra, and 105 crank arms and corresponding bottom brackets are the “5mm-spline” type. The critical spline dimensions of this type are that the eight lands (ridges) are 2.2mm thick and 5mm long. The second pattern, commonly found on Shimano MTB cranks (except XTR) and corresponding bottom brackets, is the “9mm-spline” type. This type has eight lands that are each 2.8mm thick and 9mm long, and it is not interchangeable with the 2.2 × 5mm pattern. After seeing both, it is effortless to visually distinguish the types from each other by the relative length of the splines (see figure 20.13).
IF REPLACING ARM(S) OR TO FACILITATE CLEANING
1. Optionally, remove pedal(s). See PEDAL REMOVAL procedure.
PREPARATION AND PRE-REMOVAL INSPECTIONS

In the next step, measure the clearance between the right-crank assembly and the chain stay (see figure 20.14). The chain stay is the frame tube that runs from the bottom bracket to the rear dropout. If the bike has raised chain stays (they connect to the seat tube above the front derailleur) or rear-suspension arms or links positioned completely above the chain, measure to the side of the seat tube instead. The measurement is useful, even if just reinstalling the same crank arm, for two reasons.

First, due to frame flex and chainring flex, there must be at least 2mm clearance between every part of the right-crank assembly and the frame. Otherwise, frame damage may occur while the bike is being ridden. Measuring before removal reveals a significant problem or borderline problem, before going to the trouble of reinstalling the arm. If clearance is poor before removal, it will be necessary to check and replace a worn-out arm or put in a longer bottom-bracket spindle if the arm is fine. If the clearance is marginal before removal, measuring will alert you to a potential problem when the arm is reinstalled. Second, after reinstalling the original arm or installing a replacement arm, measuring the change in the clearance reveals whether it will be necessary to readjust the front derailleur.

2. Measure clearance between chain stay and part of right crank that comes closest to chain stay (usually inner chainring or bolt heads holding on inner chainring but occasionally another chainring, see figure 20.14). Record measurement here: \[ \text{mm} \]

NOTE: If rear stays or suspension arms are in a position where chainring rub is not an issue, measure clearance to a main-frame member.
3. Measure chainline error, record here: \( \text{mm} \)  
   Chainrings \( \text{out (+)} \) or \( \text{in (-)} \) (check one)  

Many of the following steps have two alternate procedures. One is for cranks that require a crank extractor and the other is for cranks that have a self-extractor mechanism. The distinguishing features of self-extractor mechanisms are that there is a ring around the crank bolt with a hole in the center (through which the crank-bolt head can be seen), and the ring has pin holes or slots for the engagement of a tool. If both features are not evident, the crank arm is not self extracting. When steps throughout this procedure have variations due to these two designs, the variations are labeled \textbf{standard only} or \textbf{self extractor only}. 

\textbf{NOTE: Since most steps in this procedure must be done once for one arm and again for the second arm, double checkboxes are provided to facilitate tracking of your progress. These double checkboxes are optional and do not affect the outcome of any automated processes of this program.}

4. \textbf{Self extractor only}: Check that ring is fully engaged (rarely, ring may be left-hand thread). 

\textbf{NOTE: Ring should not be tightened—removal will be difficult! If ring is not fully engaged, watch carefully during step 5 for ring unthreading further while loosening bolt!}

There is a possibility that the crank arm is self extracting. In this case, the arm will come off as the bolt is loosened, and the arm and bolt will stay together as a unit. If this is the case, watch closely for the ring around the bolt head unthreading as the bolt is loosened.
5. **Standard only:** Remove bolt, then look closely for washer in crank arm and remove it.

**Self extractor only:** Break loose bolt (bolt torque is being released), continue to unthread bolt, then break loose bolt again (press fit is being released). *NOTE: Hold on to arm while threading bolt out fully so arm will not fall off spindle.*

*NOTE: Self extractor only, steps 6–9 do not apply. Go to step 10.*
CRANK-ARM REMOVAL AND INSPECTION

In the following steps, a crank-arm extractor is installed and a crank arm removed. This is a very critical procedure. If done improperly, the crank arm or the spindle can be destroyed. See table 20-1 to select an appropriate extractor. It is critical that the extractor is compatible with the thread of the crank arm and with the shape of the end of the spindle. If using one of the recommended tools, simply follow the guidelines indicated in the table.

If a spline-crank-specific tool is not available, then a variety of adapters are available so that a tool made for a square-fit crank may be used. Adapters are listed in table 20-1. The following procedure presumes a spline-specific tool is being used, so there are no comments that say to install the adapter before the extractor or to remove the adapter after removing the extractor.

When threading the extractor into the crank arm, it should go in easily using just fingers. If the extractor does not thread in easily, it may be cross-threading or the threads may be damaged. To avoid cross-threading, align the shaft of the extractor in line with the spindle axis rather than perpendicular to the face of the crank arm. If the threads are damaged, move ahead to the section of this chapter titled REMOVING CRANK ARMS WITH DAMAGED EXTRACTOR THREADS.
In step #6 the extractor is secured in the arm with a wrench. There is no particular torque and a lot of force is not required. The purpose is simply to ensure that the extractor is fully installed instead of just hanging up on a rough thread. If it is installed fully and it begins to rotate further during arm removal, stop the procedure before unrecoverable damage occurs.

**NOTE:** *Using a square-fit-specific tool without an adapter will be completely ineffective and may destroy the bottom bracket!*

6. Thread extractor into crank arm with fingers and snug with wrench.

A common mistake is to fail to install the extractor all the way in because the extractor shaft bottoms against the spindle before the extractor is fully threaded into the crank arm. Step #7 is a safety check so that this does not happen. If everything is set up right when the extractor body is secured with a wrench, it should still be possible to turn the extractor shaft either way with fingers (see figure 20.16). If the extractor shaft cannot be turned with fingers, the shaft is engaging the spindle before the extractor body is fully engaged in the crank-arm threads. When there is poor thread engagement, crank-arm-thread failure is likely to occur.

7. Check with fingers whether extractor shaft turns (see figure 20.16) and check one of following choices:
   - Shaft is tight, loosen it further and re-snug extractor into crank.
   - Shaft is loose, ready for arm removal.
In step #8, tighten the extractor shaft to remove the crank arm (see figure 20.17). At this point in the procedure, there is still a possibility of removal failure and damage to the crank arm. If the correct warning signs are looked for during arm removal, it may be possible to detect a failure before the damage gets critical, solve the cause of the problem, and then successfully remove the arm. While tightening the extractor shaft, simultaneously watch for either of the following warning signs. First, if the extractor body starts to rotate, the crank-arm extractor-threads may be stripping. Second, if the extractor appears to begin pulling out of the arm (or starts cocking to one side in the arm), the crank-arm extractor-threads may be pulling out. In both cases, immediately stop tightening the extractor shaft and remove the extractor from the arm. Inspect for a bolt or washer that was not removed. Inspect thread compatibility of the extractor to the crank arm, and inspect for compatibility of the extractor type with the spindle type. If no problems are found, then the only problem might be that the arm is seized to the spindle. Flood the hole with penetrating oil and attempt removal again.

8. Tighten extractor shaft to remove crank arm (see figure 20.17).
9. With arm still on spindle but loose, break loose extractor from crank arm.

10. **Self extractor only:** Unthread self-extractor ring, remove bolt and washer from threaded hole, and remove anti-friction washer (brass or plastic) from inside face of ring or from bolt head. **NOTE:** Many self-extracting bolts have built-in steel washers or plastic washers that are snapped into groove in bolt head. Do not use force to remove any washers!
11. Optional: Remove chainrings (see REMOVING CHAINRINGS).
DAMAGE INSPECTION

12. Inspect arm for cracks originating at spline hole in each crank arm and circle one choice for each arm removed:
   Right arm   OK       not OK  (check one)
   Left arm    OK       not OK  (check one)

   **NOTE: If not OK, arm(s) must be replaced.**

13. Inspect for cracks originating at pedal-mounting hole in each crank arm and circle one choice for each arm removed:
   Right arm   OK       not OK  (check one)
   Left arm    OK       not OK  (check one)

   **NOTE: If not OK, arm(s) must be replaced.**

14. Inspect right arm (if removed) for cracks at crotch of spider arms to crank arm.
   OK       not OK  (check one)

   **NOTE: If not OK, arm must be replaced!**
CRANK-ARM INSTALLATION

15. Install chainrings, if removed (see ASSEMBLY OF CHAINRINGS TO CRANK ARM).

INSTALLING A PAIR OF CRANK ARMS

16. ISIS only: Use grease or anti-seize compound to treat spindle splines.
   Octalink only: Grease spindle splines and cylindrical taper immediately inward from splines.

17. Grease steel washer (if any), bolt threads, and under bolt head. **NOTE: Go to step 21 if one crank arm was removed and only one needs to be installed.**

INSTALLING RIGHT ARM

18. Place right arm on spindle so splines are engaged. Check engagement by holding left end of spindle stationary and trying to rotate right crank arm.

19. Install washer (if any) and bolt, then use either choice A or choice B below:
   A: Manufacturer’s maximum recommended torque (see table 20-3 or use manufacturer’s published recommendations) then check for ≥2mm clearance of chainrings to frame.
   B: In absence of manufacturer’s recommendations, torque to 420in-lbs, then check for ≥2mm clearance of chainrings to frame.

20. Self extractor only: Install anti-friction washer (if any) to bolt head, grease inside face of ring, treat ring threads with Loctite 242, then thread ring in fully. **DO NOT SNUG!!**
**Installing Second Arm**

21. Place arm on spindle so that it points 180° away from already-installed arm, then check engagement of splines by holding one arm stationary and trying to rotate other arm.

22. Install washer (if any) and bolt or nut, then use either choice A or choice B below:
   - **A:** Manufacturer’s maximum recommended torque (see table 20-3 or use manufacturer’s published recommendations) then check for ≥2mm clearance of chainrings to frame.
   - **B:** In absence of manufacturer’s recommendations, torque to 420 in-lbs, then check for ≥2mm clearance of chainrings to frame.

23. **Self extractor only:** Install anti-friction washer (if any) to bolt head, grease inside face of ring, treat ring threads with Loctite 242, then thread ring in fully. **DO NOT SNUG!**

**Checking Need for Front-Derailleur Adjustment**

24. Measure chainring-to-frame clearance (as in step 2):
   - Original measurement transferred from step 2: mm
   - Change in chainring clearance (if any): mm

   **NOTE:** If change value above is more than .2 or less than –.2, front-derailleur performance may change!

   **NOTE:** Skip to step 28 if arms installed are original arms removed (not replacements).
CHECKING FIT OF REPLACEMENT ARM

CHECKING CHAINRING FIT IF REPLACEMENT ARM IS A RIGHT ARM

If using old chainrings with a new crank arm, check the **CHAINRINGS** chapter to determine whether the new arm is compatible with the chainrings. Chainring compatibility is not just a matter of whether the mounting holes in the chainrings and the crank arm match. With some chainrings, spacing between the two is critical and not universal.

In the next step, measure the chainring clearance. With the new arm installed, check the chainring position. Any change in clearance could represent a potential problem with shifting, chainline alignment, and frame clearance. Step #25 establishes whether the chainrings have changed position in a way that will cause a problem with frame clearances and whether they have changed position enough to require adjustment of the front derailleur. Step #26 and #27 establish whether any chainline error has worsened or improved.

Some bikes have raised chain stays (chain stays that are above the chainrings and do not overlap the chainrings) or rear-suspension arms/links that do not overlap the chainrings. In these cases, clearance between the chainrings and the frame is no longer an issue. However, changes in chainring position still affect front-derailleur adjustment and chainline. With these bikes, clearance to the chain stays cannot be measured, so the distance between the chainrings and another frame part should be measured.
25. Measure chainring-to-chain-stay clearance (measure clearance to seat tube if bike has raised chain stays) and enter new clearance here:

Original clearance from step 2 is transferred to here:

Clearance change is:

Check A, B, or C choice below:

A: Clearance is ≥2mm (ignore for bikes with raised chain stays) and clearance is > .2mm different than number in step 2. **NOTE:** *Front derailleur limit screws and cable will need adjustment!*

B: Clearance is < 2mm. **NOTE:** *Replacement arm is unacceptable to use with existing spindle!*

C: Clearance is different by ≤ .2mm from number in step 2. **NOTE:** *Front derailleur adjustment is not needed. Arm is a good fit.*

In the next two steps, measure the chainline after installing a new right crank arm to determine whether it has been changed enough to create or solve a problem. Don’t limit your focus to whether there is a measurable error, but include whether the error has changed enough to introduce or eliminate chainline error symptoms. See **CHAINLINE** chapter for information about how to measure chainline error and symptoms of chainline error.
26. Measure chainline error, record here: mm
   Chainrings  out (+)  or  in (-)  (check one)

27. Compare step 26 to step 3 results: mm (out    in    )
   Then, choose one of following choices:
   Error is equal to step 3. **NOTE: Arm is acceptable if no chainline-
   error symptoms were experienced with original arm.**
   Error is in the same direction but less than step 3. **NOTE: Arm is
   acceptable unless previous chainline error was unacceptable and
   change is not enough to eliminate symptoms. Bike should be evalu-
   ated for chainline-error symptoms!**
   Error is in new direction. **NOTE: Bike should be evaluated for
   chainline-error symptoms.**
   Error is in same direction but greater. **NOTE: Bike should be eval-
   uated for chainline-error symptoms!**
INSTALL PEDALS

28. Install pedal(s) if removed. See PEDAL INSTALLATION.
REMOVING CRANK ARMS WITH DAMAGED EXTRACTOR THREADS

MANGLED THREADS

With luck, the only problem being experienced is getting the extractor to start threading into the crank arm without jamming. For square-fit crank arms only, there is a simple repair. The tool needed is a Bicycle Research TC-8 crank-arm-thread chaser. This simple tool has a pilot shaft that attaches to the spindle once the nut/bolt is removed. A thread chaser slips over the pilot and then threads into the crank arm, re-aligning the mangled threads (see figure 20.18). Removal of the crank arm is then done normally after removing the TC-8.

1. Attach pilot shaft to spindle.
2. Lubricate threads of thread chaser with aluminum cutting oil or other very light oil.
3. Slip chaser onto pilot shaft and thread chaser into crank arm. Resistance may be encountered and force may be necessary to thread chaser in fully.
4. Remove thread chaser and pilot and attempt normal removal of crank arm. If threads fail, proceed to STRIPPED THREADS.
STRIPPED THREADS

**Repair with Stein CES**

The Stein CES can be used to replace stripped threads in crank arms attached to a square spindle and retained by a bolt. It can also be used to replace stripped threads in crank arms attached to a splined spindle and retained by a bolt with a 15mm-diameter thread. This tool cannot be used with splined spindles that accept a bolt with a 12mm-diameter thread.

1. Remove all rings, bolts, and washers from crank arm with damaged thread.
2. Thread CES pilot shaft into hole in spindle.
3. Treat CES tap generously with cutting oil, then use tap to create new threads in crank arm. *NOTE: Use of standard cut-and-clear tapping technique is critical to success.*
4. Remove tap and pilot shaft, then thoroughly clean new threads and spindle hole.

There are two options once the thread is repaired. The least-expensive option is to rely on the CES crank extractor for all future crank removals. This tool is part of the kit (also available separately), but relying on the CES extractor for all future removals limits the customer to service in shops that are equipped with the CES extractor (not common). The other alternative is to sell the CES self extractor to the customer, so the crank can removed with a standard hex key from this point on. If taking the first option, simply install the CES extractor at this point and perform a normal removal with a crank extractor. Continue with step #5 if installing the CES self extractor.

5. Grease steel washer that goes between bolt head and arm, grease bolt threads, and grease under bolt head.
6. **Square-fit only**: Install washer (if any) and bolt or nut, then use either choice **A** or choice **B** below:
   
   **A**: Manufacturer’s maximum recommended torque (see table 20-2 or use manufacturer’s published recommendations) then check for ≥2mm clearance of chainrings to frame.
   
   **B**: In absence of manufacturer’s recommendations, torque to 350in-lbs, then check for ≥2mm clearance of chainrings to frame.

7. **Spline-fit only**: Install washer (if any) and bolt, then use either choice **A** or choice **B** below:
   
   **A**: Manufacturer’s maximum recommended torque (see table 20-3 or use manufacturer’s published recommendations) then check for ≥2mm clearance of chainrings to frame.
   
   **B**: In absence of manufacturer’s recommendations, torque to 420in-lbs, then check for ≥2mm clearance of chainrings to frame.

8. Install anti-friction washer (if any) to bolt head, grease inside face of ring, treat ring threads with Loctite 242, then thread ring in fully. **DO NOT SNUG!**

9. Use self-extractor method to remove arm.

**Removal of arm for replacement**

Stripped threads are clearly identified when the extractor pulls out of the arm, instead of the arm pulling off of the spindle when attempting arm removal. In this case, count on needing a new arm (if Stein CES repair is not an option). The problem is how to get the arm off in order to replace it. The following steps actually include two methods for arm removal. If at the end of step #4 the arm has loosened adequately, then no more is needed. If not, continue to the end of the steps.
Many modern right arms are shaped in such a way that there is no flat surface to strike with the hammer. Since the arm should be considered a loss already, the solution to this is not as drastic as it sounds. Remove the chainrings and use a hacksaw to cut off the chainring-mounting arm that is just past the chainring-mounting arm that is immediately adjacent to the crank arm. This should create the spot needed to strike with the hammer.

1. Reinstall any arm or pedals that have been removed and put bike in rideable condition.
2. Install nut/bolt onto spindle on side with stripped extractor threads in arm, then loosen nut/bolt 2–3 full turns.
3. In a parking lot free of traffic or up a steep hill, ride bike hard. (Use brakes to create resistance in flat parking lots.) Crank arm should loosen noticeably. If not, proceed to next step.

**NOTE:** Following procedure has not been checked on spline-fit crank arms; use only as a last resort on spline-fit arms! Potential problems are either nothing will happen or bottom bracket will be destroyed.

5. With crank arm horizontal, support crank arm under the end in which spindle is inserted in on anvil or some other firm support (see figure 20.19). **NOTE:** It is probably necessary to saw off chainring mounting arms (if not removable type) to do this step to right crank arm.

6. Strike top side of arm with a ballpeen hammer as hard as possible with control. Strike repeatedly until crank arm pops off of spindle. (Arm is not reusable.)
**SPLIT-SPLINE CRANKS**

Split-spline crank arms are technically not press-fit arms but are covered in this chapter since there is no more appropriate chapter. Split-spline crank arms connect to a splined spindle that has no taper. The crank arm has a compression slot (split) in the end of the arm that attaches to the spindle. A binder bolt or two binder bolts are tightened to compress the hole in the arm and secure the arm to the spindle.
GENERAL GUIDELINES

The mating surfaces of the arm and spindle should be liberally greased or treated with an anti-sieze compound. The binder bolt(s) should have the threads and under the head treated with grease or an anti-seize compound. There may be a bolt that threads into the end of the spindle that caps the hole, acts as a secondary retention device, and/or acts as an adjustment for the preload on the bottom-bracket bearings. When this spindle-end bolt performs a preload function, it is adjusted when the binder bolt(s) on the split are loosened. The spindle-end bolt may need to be torqued, but depending on its function, the torque might be applied before or after the binder bolt(s) are torqued. Contact the crank manufacturer for more specific guidelines on procedures and torques. These guidelines apply to unspecified brands.

See the next topic for detailed information about Shimano Hollowtech II cranks, including the following models:

'03–'04 XTR (FC-M960)
'04 Deore XT (FC-M760)
'04 Saint (FC-M800)
'04 Dura-Ace 10spd (FC-7800)
SHIMANO HOLLOWTECH II CRANKS (XTR, SAINT, DEORE XT, DURA-ACE)

**Tool requirements**

Bottom-bracket installation/removal: Shimano TL-FC32 or TL-FC33
Crank-arm installation/removal and bearing preload: Shimano TL-FC16

**Crank-arm/bottom-bracket removal**

1. Use Shimano TL-FC16 to remove spindle-cap bolt from left arm, loosen binder bolts, pull left arm off spindle, then remove O-ring.
2. Remove right arm/chainring assembly from right side of bottom bracket, noting O-ring in holder on back face of arm.
3. Use Shimano TL-FC32/TL-FC33 to remove bearing assemblies, noting positions of spacers between cups and shell.

**Bottom-bracket installation**

1. Treat bottom-bracket threads with Loctite 242.

**NOTE:** Spacer locations in step 2 are manufacturer’s recommendations to achieve acceptable chainline. Deviations may be required for clearance. Check clearances and adjust spacers as necessary.

2. **Dura-Ace only:** Install main assembly into right end of shell.
   - **MTB 68mm shell only:** Install main assembly into right end of shell with two spacers between right end of shell and assembly.
   - **MTB 68mm shell with E-type derailleur only:** Install main assembly into right end of shell with one spacer adjacent to shell and derailleur bracket between spacer and inside face of bearing housing.
   - **MTB 73mm shell only:** Install main assembly into right end of shell with one spacer between right end of shell and assembly.
   - **MTB 68mm shell with E-type derailleur only:** Install main assembly into right end of shell with derailleur bracket between shell and inside face of bearing housing.
3. Install one spacer and left-side bearing assembly into left end of shell (no spacer for 73mm-shell-MTB or Dura-Ace setups).

4. **E-type derailleur only:** Align derailleur bracket with stud on frame, then install and secure bolt.

5. Using Shimano TL-FC32/TL-FC33, secure both sides to equivalent of 305–435in-lbs.

**INSTALLING RIGHT-SIDE ASSEMBLY**


7. Install O-ring holder (flat-face first) onto spindle, then place O-ring inside holder (these items are pre-installed on out-of-the-box cranks).

8. Install assembly into bottom-bracket shell.

**INSTALLING LEFT ARM AND SETTING PRELOAD**

9. Remove binder bolts from left arm and grease threads and under bolt heads.

10. Install O-ring onto left end of spindle.

11. Install left arm 180° from right arm (wide spline inside arm should align with wide groove in left end of spindle).

12. Treat threads of spindle-cap bolt with Loctite 242, install bolt into left end of spindle, then secure bolt to approximately 4–6in-lbs (using Shimano TL-FC16).

**SECURING LEFT ARM**

13. Install binder bolts into holes in spindle end of left arm.

14. Tighten both bolts to 90–130in-lbs. **NOTE: Torquing each bolt once is not sufficient! After torquing each bolt, return to previous bolt and check torque again—continue cycling between bolts until both fail to turn prior to moment torque wrench is indicating torque has been achieved!**
20.1a These are examples of splined spindle ends that accept a spline-fit crank arm. Both examples are Shimano Octalink designs (eight splines). Another common design is the ISIS configuration, which is distinguished by ten splines and which does not have the cylindrical portion at the end of the splines as shown above.

20.1b Cross-section of a square-fit crank arm attached to a spindle.

20.2 Use a stack of feeler gauges to measure the clearance between the chain stay and the part of the crank assembly that comes closest to rubbing the chain stay (or any other part of the frame).

20.3 The left picture shows the position of the spindle when fit is good and the right one shows when fit is bad, because the square portion of the spindle fills the full depth of the square hole in the crank arm.

20.4 This picture shows the two types of spindle ends with the corresponding correct remover to use. Note that the extractor used with a spindle that has a threaded stud on the end has a domed and relatively narrow tip. Note that the extractor used with a spindle that has no threaded stud on the end is flat on the end and has a relatively fat tip.

20.5 The drawing shows that a properly installed extractor must be in line with the spindle axis, but not necessarily perpendicular to the face of the crank arm.

20.6 When the extractor is properly installed and when ready to remove the arm, the extractor body should be tight and the shaft should be loose and easily turned with fingers.

20.7 Turn the extractor shaft clockwise with a wrench to remove the crank arm.

MORE FIGURES
20.8 The marks on the left spindle indicate good fit because they do not cover the full length of the spindle flat. The marks on the right spindle indicate poor fit because they cover the full length of the spindle flat.

20.9 Compare the hole in the left crank arm (good) to the hole in the right crank arm (damaged).

20.10 Strike the crank arm with a rubber/plastic mallet to temporarily secure the arm to the spindle. Pull on the arm to check that it does not jiggle or come off.

20.11 Use the tip of a finger against the inner face of the outer chainring teeth. As the chainrings spin, check the degree of wobble.

20.12 Tap on the back of the crank arm with the rubber/plastic mallet to remove the crank arm in order to check chainring wobble in another of the four possible mounting positions of the right crank arm.

20.13 Shimano Octalink spline configurations.

20.14 Use a stack of feeler gauges to measure the clearance between the chain stay and the part of the crank assembly that comes closest to rubbing the chain stay (or any other part of the frame).

20.15 The drawing shows that a properly installed extractor must be in line with the spindle axis but not necessarily perpendicular to the face of the crank arm.

20.16 When the extractor is properly installed and when ready to remove the arm, the extractor body should be tight and the shaft should be loose and easily turned with fingers.

MORE FIGURES
20.17 Turn the extractor shaft clockwise with a wrench to remove the crank arm.

20.18 After attaching the pilot shaft to the spindle, thread the chaser part of the TC-8 into the crank arm to re-align the threads.

20.19 With the nut/bolt removed and the arm supported on an anvil or similar surface, strike hard and repeatedly with a ballpeen hammer to get the arm to pop off.
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20.16 When the extractor is properly installed and when ready to remove the arm, the extractor body should be tight and the shaft should be loose and easily turned with fingers.
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PRESS-FIT CRANK-ARM TOOLS (Table 20–1)
SQUARE-FIT CRANK TORQUES (Table 20–2)
SPLINE-FIT CRANK TORQUES (Table 20–3)
CRANK-ARM TROUBLESHOOTING (Table 20–4)
## PRESS-FIT CRANK-ARM TOOLS (table 20-1)

<table>
<thead>
<tr>
<th>Tool</th>
<th>Fits and considerations</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>EXTRACTORS</strong></td>
<td></td>
</tr>
<tr>
<td>Campagnolo UT-FC060</td>
<td>Standard-thread extractor, works with bolt-type square spindles only</td>
</tr>
<tr>
<td>Campagnolo UT-FC070</td>
<td>22 × 1mm <em>left-hand-thread</em> extractor for Campagnolo C-Record track cranks and road cranks that are missing original self-extractor system (rarely needed)</td>
</tr>
<tr>
<td>Lifu 04C1</td>
<td>Standard-thread extractor, works with bolt-type square spindles only</td>
</tr>
<tr>
<td>Park CCP-2 and</td>
<td></td>
</tr>
<tr>
<td>Park CCP-4</td>
<td>CCP-2 is standard-thread extractor for square-hole crank arms with either nut-type or bolt-type spindles; CCP-4 is for spline-fit crank arms; both have poor leverage due to length of built-in handle and lack of choice for leverage position (tools without built-in handle can have wrench positioned where needed)</td>
</tr>
<tr>
<td>Park CWP-6</td>
<td>Standard-thread extractor, works with nut-type and bolt-type square spindles or spline spindles; problematic due to potential to misplace small tips that must be switched for each type of crank</td>
</tr>
<tr>
<td>Pedro’s 6541205</td>
<td>Dedicated extractor for common types of spline-fit cranks (Octalink and ISIS)</td>
</tr>
<tr>
<td>Pedro’s 6451200</td>
<td>Standard-thread extractor, works with bolt-type square spindles only</td>
</tr>
<tr>
<td>Shimano TL-FC10</td>
<td>Standard-thread extractor, works with bolt-type square spindles only</td>
</tr>
<tr>
<td>Sugino Maxi 203</td>
<td>Standard-thread extractor, works with old-style nut-type square spindles only</td>
</tr>
<tr>
<td>VAR 11</td>
<td>Standard-thread extractor, works with bolt-type square spindles only</td>
</tr>
<tr>
<td>United Bicycle Supply TA-EXT</td>
<td>23 × 1mm (fits <em>rare</em> T.A. cranks), removes from bolt-type square spindles only</td>
</tr>
<tr>
<td>United Bicycle Supply STEX (by Stein)</td>
<td>Fits <em>rare</em> Stronglight cranks with 16mm bolt and unique 23.35 × 1mm thread</td>
</tr>
<tr>
<td>VAR 392/2</td>
<td>Standard-thread extractor, works with bolt-type square spindles only</td>
</tr>
</tbody>
</table>

**MORE TOOLS**
### PRESS-FIT CRANK-ARM TOOLS (table 20-1)

<table>
<thead>
<tr>
<th>Tool</th>
<th>Fits and considerations</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>ADAPTERS FOR EXTRACTORS</strong></td>
<td></td>
</tr>
<tr>
<td>Shimano TL-FC15</td>
<td>Adapts all standard-thread extractors for bolt-type square spindles to work with splined spindles with 15mm bolt hole; best substitute for not having dedicated spline-fit crank extractor such as Pedro’s 6541205</td>
</tr>
<tr>
<td>United Bicycle Supply UB-FC15</td>
<td>Adapts all standard-thread extractors for bolt-type square spindles to work with splined spindles with 12mm bolt hole; best substitute for not having dedicated spline-fit crank extractor such as Pedro’s 6541205</td>
</tr>
<tr>
<td><strong>OTHER CRANK-ARM TOOLS</strong></td>
<td></td>
</tr>
<tr>
<td>Bicycle Research TC-8</td>
<td>Thread chaser, repairs mangled 22 × 1mm crank-arm threads</td>
</tr>
<tr>
<td>Shimano TL-FC20</td>
<td>Fits two-pin-hole dustcap on older Shimano crank arms</td>
</tr>
<tr>
<td>Stein CES</td>
<td>Converts stripped 22 × 1mm threads to 24 × 1.5mm; comes with shop extractor (24 × 1.5mm) and self-extractor system to be left installed in crank; works with bolt-type square spindles and splined-fit cranks; expensive but indispensable</td>
</tr>
</tbody>
</table>
### SQUARE-FIT CRANK TORQUES (table 20-2)

<table>
<thead>
<tr>
<th>Manufacturer</th>
<th>Minimum–Maximum Torque</th>
</tr>
</thead>
<tbody>
<tr>
<td>Campagnolo</td>
<td>285–335in-lbs</td>
</tr>
<tr>
<td>Full Speed Ahead (FSA)</td>
<td>304–347in-lbs</td>
</tr>
<tr>
<td>Race Face</td>
<td>420–480in-lbs</td>
</tr>
<tr>
<td>Shimano</td>
<td>305–390in-lbs</td>
</tr>
<tr>
<td>TruVativ</td>
<td>335–370in-lbs</td>
</tr>
</tbody>
</table>
## Spline-Fit Crank Torques (Table 20-3)

<table>
<thead>
<tr>
<th>Manufacturer</th>
<th>Minimum–Maximum Torque</th>
</tr>
</thead>
<tbody>
<tr>
<td>Full Speed Ahead (FSA)</td>
<td>434–521 in-lbs</td>
</tr>
<tr>
<td>Race Face</td>
<td>First installation: 480 in-lbs</td>
</tr>
<tr>
<td></td>
<td>Reinstallation: 420 in-lbs</td>
</tr>
<tr>
<td>Shimano</td>
<td>305–435 in-lbs</td>
</tr>
<tr>
<td>TruVativ</td>
<td>385–420 in-lbs</td>
</tr>
</tbody>
</table>
# CRANK-ARM TROUBLESHOOTING (table 20-4)

<table>
<thead>
<tr>
<th>Cause</th>
<th>Solution</th>
</tr>
</thead>
<tbody>
<tr>
<td>SYMPTOM: <em>When riding, one ankle feels as though the end of the pedal is rocking up and down and/or it feels as though the surface of the pedal is rotating back and forth.</em></td>
<td>Pedal shaft is bent from a crash. Remove pedal and inspect end of pedal shaft for oscillation when rotating. Replace if bad. If symptom persists when pedal shaft is good, crank arm is bent and should be replaced.</td>
</tr>
<tr>
<td>If pedal shaft is not bent, crank arm is bent.</td>
<td>Replace crank arm.</td>
</tr>
<tr>
<td>SYMPTOM: <em>A popping sound or sensation is experienced once per crank revolution, often on the down stroke of the right pedal.</em></td>
<td>Loose crank arm. Check and secure crank arm.</td>
</tr>
<tr>
<td>Loose pedal-body piece(s).</td>
<td>Check and secure pedal-body piece(s).</td>
</tr>
<tr>
<td>Loose pedal mounting.</td>
<td>Check and secure pedal mounting.</td>
</tr>
<tr>
<td>Loose chainring-mounting bolt(s).</td>
<td>Check and secure chainring-mounting bolt(s).</td>
</tr>
<tr>
<td>Loose bottom-bracket cup, lockring, or retaining ring.</td>
<td>Check and secure bottom-bracket cups, lockrings, or retaining rings.</td>
</tr>
<tr>
<td>Bent chainring tooth.</td>
<td>Inspect and bend back.</td>
</tr>
<tr>
<td>SYMPTOM: <em>A ticking or scraping sound is heard once per crank revolution.</em></td>
<td>Loose crank arm causing chainring wobble, causing chain to scrape derailleur cage.</td>
</tr>
<tr>
<td>Crank arm is hitting front-derailleur cage.</td>
<td>Re-adjust front-derailleur limit screws and/or rotational alignment.</td>
</tr>
</tbody>
</table>

**MORE TROUBLESHOOTING**

**BARNETT’S MANUAL DX DEMO CHAPTER: LINKS TO OUTSIDE THIS CHAPTER ARE NOT ACTIVE**
<table>
<thead>
<tr>
<th>Cause</th>
<th>Solution</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>SYMPTOM:</strong> Chainrings, chainring-mounting bolts, or some other part of the crank-arm assembly is rubbing the chain stay continuously or intermittently when the crank is being spun when not under load.</td>
<td>Crank arms worn out or bad fit to spindle. Perform removal process, including fit inspections.</td>
</tr>
<tr>
<td>Bottom bracket spindle is too short.</td>
<td>Replace spindle or cartridge bottom bracket with one that will position crank arm out further.</td>
</tr>
<tr>
<td><strong>SYMPTOM:</strong> Wear marks are found on the chain stay where they might have been left by the chainrings, chainring-mounting bolts, or some other part of the crank-arm assembly, but no rubbing is evident upon visual inspection.</td>
<td>Clearance that is adequate without load is not adequate when crank assembly and/or frame flexes under load. Check for and replace worn-out or misfit crank arm. Replace spindle or cartridge bottom bracket with one that will position crank arm out further.</td>
</tr>
<tr>
<td><strong>SYMPTOM:</strong> Extractor mounting threads fail when crank-arm removal is attempted.</td>
<td>Extractor was not fully threaded into crank arm. Attempt repair with Bicycle Research TC-8 thread chaser. If threads fail completely when attempting removal again, use Stein CES procedure or procedure for removing crank arms with damaged extractor-mounting threads.</td>
</tr>
<tr>
<td>Crank-arm removal was attempted without removal of the retaining nut or bolt, or without removal of the washer that was under the bolt head.</td>
<td>Crank-arm removal was attempted without removal of the retaining nut or bolt, or without removal of the washer that was under the bolt head. Attempt repair with Bicycle Research TC-8 thread chaser. If threads fail completely when attempting removal again, use Stein CES procedure or procedure for removing crank arms with damaged extractor-mounting threads.</td>
</tr>
<tr>
<td>Crank arm was mounted excessively tightly.</td>
<td>Crank arm was mounted excessively tightly. Use Stein CES procedure or procedure for removing crank arms with damaged extractor-mounting threads.</td>
</tr>
</tbody>
</table>
### CRANK-ARM TROUBLESHOOTING (table 20-4 continued)

<table>
<thead>
<tr>
<th>Cause</th>
<th>Solution</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>SYMPTOM:</strong> A creaking sound is coming from the crank, particularly under hard pedaling load.</td>
<td>Check and secure crank arm.</td>
</tr>
<tr>
<td>Crank arm is loosening.</td>
<td>Check and secure crank arm.</td>
</tr>
<tr>
<td>Mating surfaces of crank arm and spindle are contaminated.</td>
<td>Remove and clean mating surfaces. Optional: add Loctite 242 or 222 to mating surfaces to fill gaps.</td>
</tr>
<tr>
<td>Crank arm is a poor fit to spindle due to incompatibility or wear.</td>
<td>Remove and inspect crank arm and spindle for evidence of poor fit. Replace if there is evidence that fit is bad.</td>
</tr>
<tr>
<td>Loose pedal-body piece(s).</td>
<td>Check and secure pedal-body piece(s).</td>
</tr>
<tr>
<td>Loose pedal mounting.</td>
<td>Check and secure pedal mounting.</td>
</tr>
<tr>
<td>Loose chainring bolt(s).</td>
<td>Check and secure chainring-mounting bolt(s).</td>
</tr>
<tr>
<td>Cracks in crank arm or chainring-mounting arms.</td>
<td>Remove, clean, and inspect crank arm and chainring-mounting arms.</td>
</tr>
<tr>
<td>Loose bottom-bracket cup, lockring, or retaining ring.</td>
<td>Check and secure bottom-bracket cups, lockrings, or retaining rings.</td>
</tr>
<tr>
<td><strong>SYMPTOM:</strong> A crank arm is repeatedly loosening.</td>
<td></td>
</tr>
<tr>
<td>Inadequate torque.</td>
<td>Use torque wrench, if not already used.</td>
</tr>
<tr>
<td></td>
<td>Use maximum recommended torque, if not already used.</td>
</tr>
<tr>
<td>Crank arm is worn out and fits poorly, or is not compatible with spindle and fits poorly.</td>
<td>Remove and inspect crank arm and spindle for evidence of poor fit.</td>
</tr>
<tr>
<td>Crank-arm and spindle-mating surfaces are contaminated with lubricant (square-fit cranks, only).</td>
<td>Clean mating surfaces and remount dry or with Loctite 242 or 222 on spindle flats.</td>
</tr>
</tbody>
</table>