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FOUNDATION SOLUTIONS LIMITED
SINCE 1897

600 Ferguson Avenue North, Wellington Street Marine Terminal
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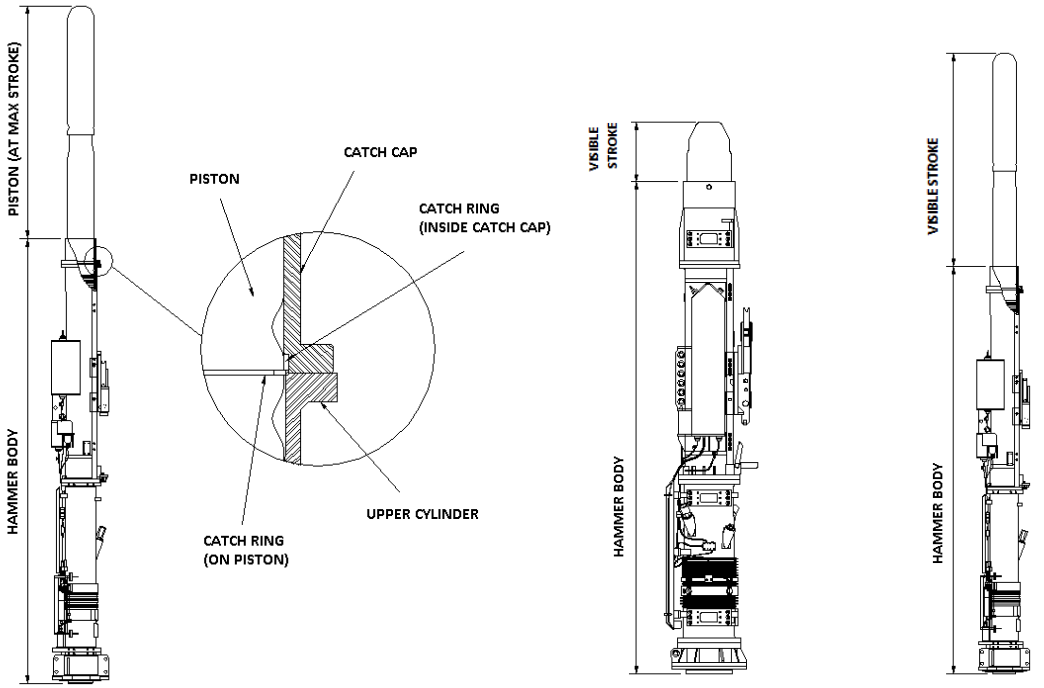
HAMMER ABUSE/NEGLECT – CAUSE AND EFFECT

Below are some of the most common types of hammer abuse/neglect and the typical causes and evidence of damages that occur from them.

Piston impacting catch cap

Critical safety feature! Shut down hammer and inspect if struck (See below)



Description: The hammers piston has a catch ring that mimics the behaviour of a piston compression ring, however its function is to expand and make contact with a internal lip in the catch cap if the piston is over-stroked. **This event 'catches' the piston and prevents it from exiting the hammer, which is an industry standard safety feature for diesel pile hammers**.

Note: different hammer models will have different amount of piston viewable out of the catch cap for the same running stroke, or blow per minute rate.

Cause: To prevent unintended contact of the piston and catch cap we recommend performing a dry drop at the beginning of a shift to purge the cylinder of any diesel or oils that could have accumulated in the combustion chamber. See pocket manual for dry drop instructions.

Possible other sources of contact are:

- Not slowly increasing the fuel to achieve a desired blow count

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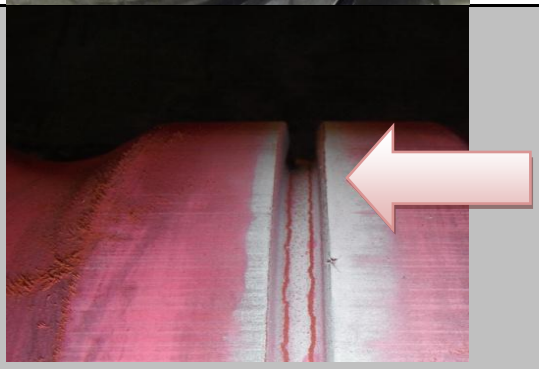
- Not closely monitoring blow count, and decreasing fuel as necessary
- Running the hammer too close to the maximum operating limits of the hammer. (see the hammers sales brochure for the limit)
- The oil pump is adjusted to provide too much oil (can result in initial higher stroke after a period of down time).

How do you know if the catch cap has been struck?

Hitting the catch cap is typically indicated by a sudden violent change in the rhythmic sound of the hammers hitting frequency, and is commonly accompanied by the hammer slightly lifting and slamming back down onto the pile. **Being a critical safety feature, anytime the catch cap is struck, the hammer must be stopped and the catch cap ring must be inspected to ensure its stop edge hasn't become rolled or chamfered.** If it has, the ring will need to be remedied.

Piston hitting catch cap end effect	
	This picture shows the removable catch cap ring (found in newer model hammers) with evidence of it being hit. These rings can be flipped over if opposite side has no damage, or must be replaced.
	This picture shows the older style catch cap (found in older model hammers), which is a stop edge feature that is machined into the catch cap. To repair this ring, the catch cap needs to be separated from the hammer and be re-machined.
	Hitting the catch cap can lead to crack formation on the catch cap groove on the piston. In this location a repair may not be possible.

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	This picture shows a portion of the catch ring that has broken off because of a catch cap strike. This renders the catch ring ineffective in catching the piston as well as leaving debris in the hammer that can damage the piston, its nose, impact area, and can severely score the cylinders bore.

Failing to keep the hammer lubricated

Description: The diesel pile hammer is basically a single piston engine and as it's important to keep a regular engine properly lubricated, the same applies to diesel pile hammers. The hammer has various moving parts that require lubrication, either periodic or constant.

Cause: The oil pump is not pumping oil into the hammer (or at too low of a rate). The piston must always appear a little wet, which can be seen though the trip slot (on the back of the hammer on the upper cylinder), and/or as the piston rises out of the catch cap. The pump can be adjusted to deliver more oil. On a low stroke (~50 BPM) you can prime the pump by squeezing the prime ball feeding the oil pump. Note when this is done it results in a temporary higher stroke in the hammer. Refer to hammer manual for further trouble shooting.

Failing to follow the pre-determined lubrication instruction within the hammer pocket manual.

Note: This table is being provided as an example, and will not be regularly updated – please refer to the Hammer Operation Manual and/or Hammer Pocket Manual.

ITEM	FREQUENCY	ACTION
IMPACT BLOCK	20 MIN. **	LUBRICATE WITH FLEX LUBE, 10 SHOTS PER FITTING
FUEL & OIL PUMP	20 MIN. **	OIL WITH TK680 3 TO 4 SHOTS PER FITTING
HAMMER GIBS (Applied to leads)	BEFORE DRIVING OR AS NEEDED	LUBRICATE WITH EP2 GREASE AS NEEDED
TRIP GIBS	BEFORE DRIVING OR AS NEEDED	LUBRICATE WITH EP2 GREASE AS NEEDED
REMOTE THROTTLE	WEEKLY OR AS NEEDED	FILL WITH DEXTRON II/III OR EQUAL
TRIP LINKAGE	MONTHLY OR AS NEEDED	LUBRICATE WITH EP2 GREASE AS NEEDED
NOTE: ** DENOTES "RUNNING TIME" FOR FURTHER SERVICE INFORMATION REFER TO THE HAMMER MANUAL		

It is equally important to remove and inspect the impact block greasing fittings and ports to ensure there are no obstruction preventing the grease from entering the hammer.

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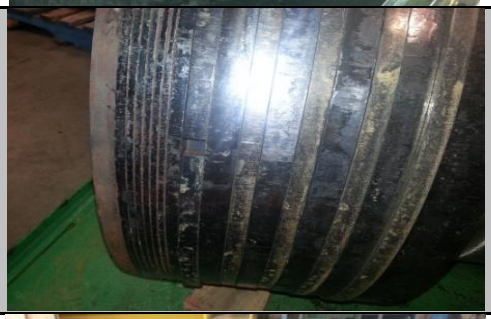
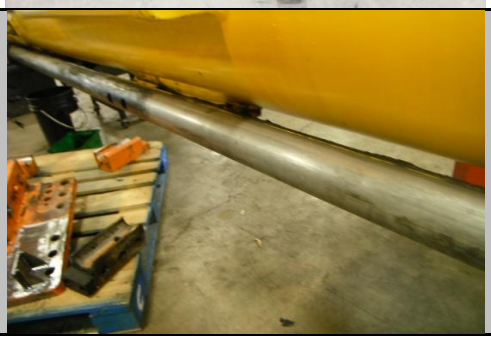
Failing to keep the hammer lubricated	
	These pictures show a dry grease port. Although this isn't immediate damage it is a clear indicator of insufficient hammer greasing which can accelerate bore wear.
	This picture shows a hammer, as received that has little to no oil within it. This results in increased friction while driving, which will not only lower driving energy but also increase heat and stresses within the hammer body. Pitting of the hammer bore and crack formation can result over time which can require cylinder re-sleeving and/or weld repair of the external hammer body.
	This picture shows an impact block which has evidence of insufficient greasing. The outer body of the impact block shows evidence that it experienced a higher heat as a result (blueing of the metals surface) which can lead to higher stresses and can reduce the life of the impact block. All of the rings will also have to be replaced as they have lost there sealing ability due to collapsed piston rings.
	This picture shows a dry piston that was removed from a hammer. The piston can be viewed through the hammers trip slot and the oil pump can be adjusted. If adjusting the oil pump is ineffective, consult the trouble shooting guide to repair the oil pump. The end damage are similar as the impact block under greasing, shown above. (accelerated wear, and premature ring wear).
	This picture shows trip rails that have not been greased regularly. This increases friction on the rails and accelerates wear on the trip gibs. It also requires more force to trip the piston which gets transferred into the upper body of the hammer and may result in cracks.

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	This picture shows excessive wear of a trip gib (due to a lack of grease), but keep in mind the gibs are a wear item. Extreme wear can lead to the hammer not being able to trip out at the proper location.
	This picture shows the results of worn trip gibs. When the gibs are excessively worn, the trip assembly can operate further away from the hammers body resulting in the lift pawl not disengaging the piston, and can damage the trip slot instead. Cracks can form in this location from the trip-hammer body contact. This is a non repairable crack.

Insufficient pre-load within the cushion stack

Description: The hammer relies on the hammer cushion stack to isolate the pile-hammer interactions so the energy created is not transferred to the hammer body and other hammer components.

Cause: During normal operation, as the cushions start to degrade due to wear and heat, the cushion stack will slowly lose its energy absorption ability and thus will start to lose its pre-load value. As the cushion stack starts to degrade, the cushioning lessens and hammer parts and hardware can start to crack and/or loosen. For this reason, it is imperative to check the cushion stack pre-load. This is accomplished by trying to insert a flat head screwdriver into the stack with minimal effort (50 psi). If the screwdriver cannot be inserted at all, the cushion stacks is still good. If the screwdriver can be inserted, the cushion stack has expired and is in need of rebuilding. Refer to the Hammer Cushion Stack Build Procedure (found in the Hammer Operation Manual) for the specific model of hammer for process and layout of cushion rings, spacer and required pre-load necessary to build the cushion stack properly.

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Continuing to run the hammer with in sufficient cushion pre-load

	This cushion stack has not been assembled correctly per our cushion stack build procedure. The bottom shows 2 new cushions, stacked up with 4 used cushions followed by all the spacers in one location. This will not distribute the loading through the stack properly and by not evenly distributing the aluminum spacers through the stack, the cushions will lose their elasticity more rapidly.
	This picture shows a stack that is well beyond needing rebuilding. The aluminium spacers, used for heat distribution, have started to break apart within the stack. At this point the cushions will have lost most of there energy absorption ability. At this point all rings/spacers must be replaced.
	Broken or loosening of bolts can occur when the cushion stack pre-load diminishes, which is a safety concern.
	Cracks can form in many areas on the hammer body and its components depending on how long a hammer is run with insufficient cushioning.

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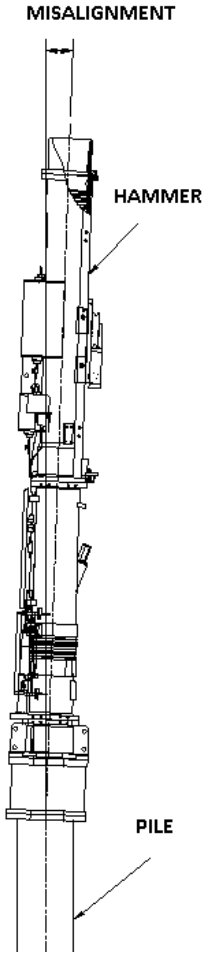


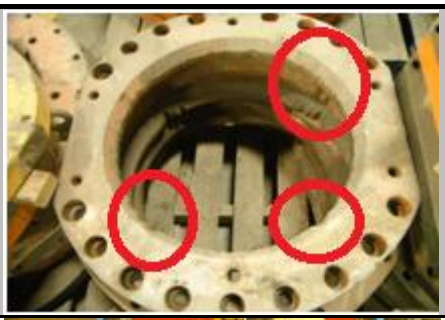
Hammer-pile misalignment

Description: This is when the hammer and pile aren't on the same angle. In addition to damage that could occur from severe or constant misalignment , the hammer will also run with a lower stroke then with a properly aligned hammer and pile.

Cause: Not closely monitoring the hammer to pile alignment and making the necessary adjustments to maintain good alignment. Once the pile is in the ground it is common that the pile will wander a little bit and it is necessary for the site personnel to make the slight adjustments to maintain proper hammer and pile alignment while driving. Misalignment can also be the result of having too small of a guide plate opening in relation to the pile size.

Immediate evidence of misalignment can be:

- A loss of stroke
- Damaged piles
- Hammer body cracks
- Loosening or broken bolts
- Premature hammer gib wear

Hammer – pile misalignment	
	This picture shows a guide plate with a uneven wear pattern. This is considered a wear item but considering where the marks are, it indicates that excess hammer forces are bypassing the cushion stack and are being applied directly to the hammer body.
	Broken and loosening bolts can start to occur due to misalignment because the pile is riding the side of the drive housing. This bypasses the hammer cushioning and can load the hammer directly with driving energy. Broken bolts have the potential of letting go of components that are bolted onto the hammer which can fall and result in injury or death.

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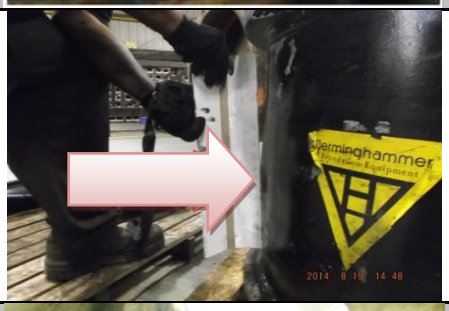
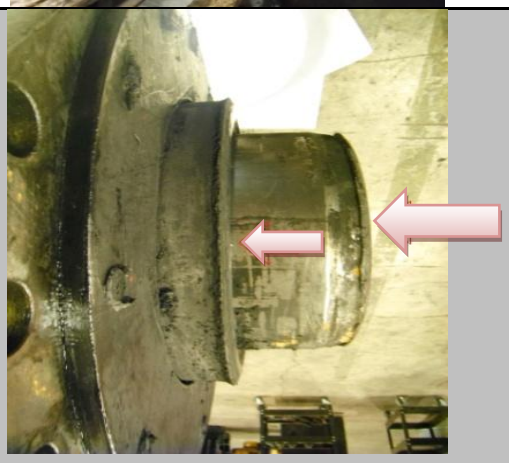
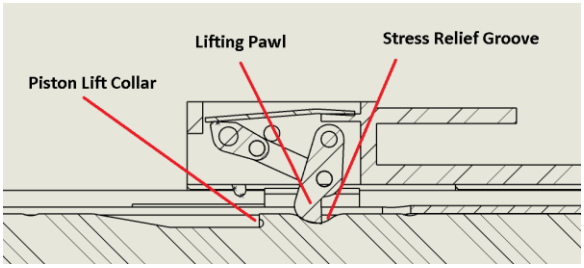
	The same as with a worn cushion stack, cracks can eventually form on the hammer body if the misalignment is not corrected.
	Extreme misalignment over time can damage the direct drive housing. In this case the damage was irreparable and the direct drive housing needed to be replaced.
	Misalignment of the hammer to the pile can cause an uneven loading condition on the moving parts between the hammers piston and the pile. Specifically between the direct drive striker plate, hammer impact block and hammer cushion retainer ring. These pieces have been designed to take periodic minor misalignment however major or continuous misalignment will overload portions of the contact surface of the parts causing deformations as shown in this picture. It is possible to repair minor misalignment related wear, however major deformations may result in having to scrap the part.
	Misalignment of the hammer to the pile can cause the hammer body to get ‘hung up’ on the pile. This can result, in some cases, for the piston to sit low enough for the trip lifting pawl to engage the hammer within the pistons stress relief feature, above the piston lift collar. This causes the trip to be wedged between the piston and the trip rails, which may cause the inability to disengage the piston from the trip. This will cause severe stresses which may lead to the formation of cracks or other damage.

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Hammer Selection and Operation

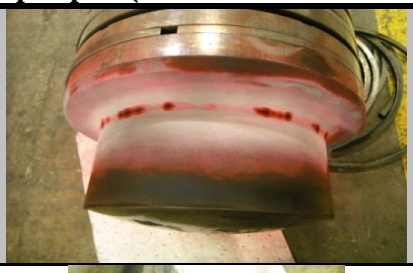
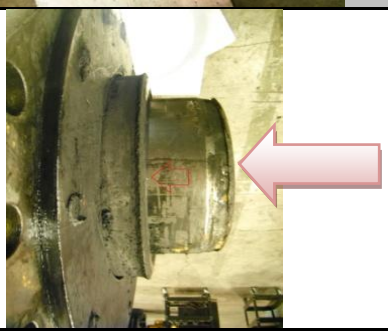
Exceeding 20 blows per inch pile penetration while driving over the rate of 40 BPM (other then pile capacity testing and/or running the hammer below the rate of 38 BPM (high stroke) for over 20 minutes per pile (40 BPM on 6505HD series of hammers).

Description: The above driving conditions may be requirements set through pile capacity testing. Although the hammer is capable of running in these states, depending on soil conditions, these conditions will put too much stress within the hammer over time.

Cause: Exceeding 20 blows per inch of pile penetration to achieve the necessary pile capacity is an indicator that the hammer is undersized for the pile capacity required on site. Not only does it mean that the hammer will need to be worked harder to achieve the final set of these piles, but the drive times will be much longer then using an adequately sized hammer.

For running the hammer below the rate of 38 bpm over 20 minutes per pile (40 BPM for the 6505HD) is also another indicator that you may have a hammer which is too small to drive the piles required on site. Site personnel may try to push the hammers to speed up drive time, when soil conditions allow, however it is at the expense of equipment life and results in hammer abuse and may result in down time while the equipment is getting repaired, and at the end-users expense.

When selecting a hammer size, pay close attention to the operating specifications found on the Hammer Sales Brochures, and feel free to consult Bermingham for assistance.

Exceeding 20 blows per inch pile penetration while driving over the rate of 40 BPM (other then pile capacity testing and/or running the hammer below the rate of 38 BPM for over 20 minutes per pile (40 BPM on 6505HD series of hammers).	
	The hammer is designed to drive piles at a reasonable rate. Exceeding these rates can lead to over stressing the components which can lead to cracks on the hammer body or the internal components such as the piston.
	Like misalignment, exceeding the recommended rates of use of the hammer, it can lead to deformations on the internal moving components, such as the piston nose (shown above) the impact block and cushion retainer ring (shown to the left).

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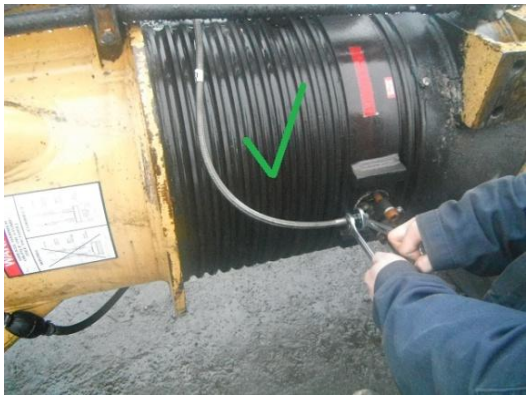
	Cracks can form not only though welded components but also though the hammer body as well. Minor cracks may be repaired however large cracks may result in having to replace a cylinder.
	Running the hammer at an increased rate for long periods of time can burn up the lubrication quicker because of the higher heat that is generated. This will cause damage that were previously discussed in the lack of lubrication section such as pitting the cylinders bore, and increased wear of the impact block and piston.

Improper installation or tightening of fuel lines



Description: Improperly installation or tightening of fuel lines can cause premature failures or leaks within the fuel lines.

Cause: The main causes of improper fuel line installation are as follows:

1) Failing to use the two wrench tightening method while connecting the lines to the injectors/fuel pump/manifolds or throttle blocks. This will make the line kink which may lead to broken strands which may puncture the internal Teflon core, or adding internal stress on where the Teflon core and end fittings connect.
2) Not ensuring that though the lines lengths there are not sharp bends or excessive stiffness when installed onto the hammer. The lines are specified to lengths which are determined for each hammer to ensure that there are not any excessive stresses at the time of assembly. Excessive twisting of the lines may cause the braid to become tight so the line is unable to flex properly while the hammer is in operation.

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3) Not ensuring clearance between hammer body and fuel line. At no point should the line make contact with the hammer body other then the end fitting connections.
4) Excessive tightening/un-tightening fittings. As with all threads the more they are tightened and loosened, the more likely they are to fail.

Improper installation or tightening of fuel lines	
	This picture shows fuel lines with visible fraying on the outer wire braid of the line. What it doesn't show is possible fraying of the internal braids which may puncher the inner Teflon core causing the fuel line to leak. This is caused by the lines rubbing other components of the hammer, sharp bends or twisting in the fuel line which synchs up the braids that will cause the line to be less flexible.
	Broken fuel line stems can be the result of excessive tightening and un-tightening of the fittings. This can lead to fatigue cracking which can propagate though the end connection. Excessive twisting of the fuel line can also result in excessive forces being transferred to the end connection which could cause failures.

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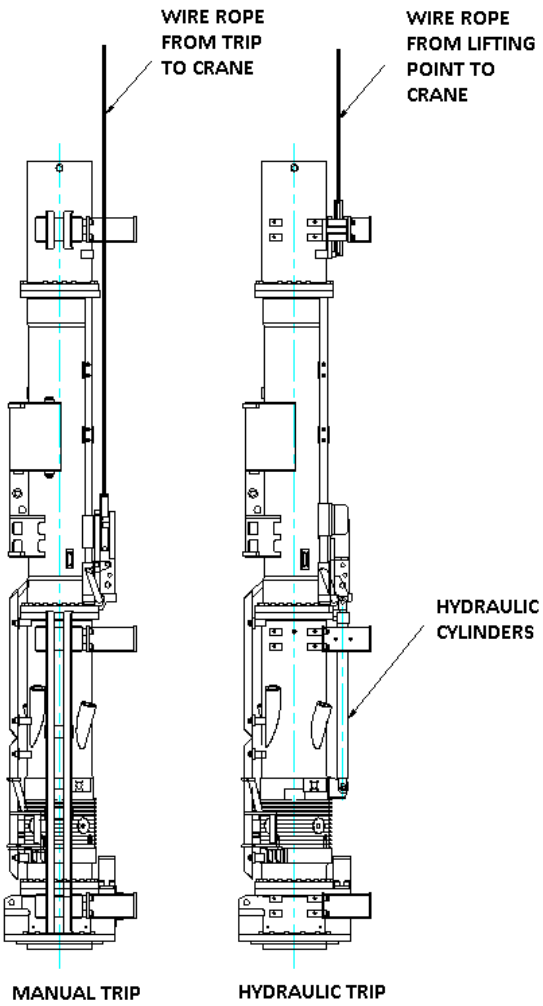
Dogging the trip: Tripping the hammer while hammer is running

Description: This is when the trip is lowered and is engaged on the trip engagement lug which results in the trip lifting pawl pivoting within bore of the cylinder while the hammer is running. This causes the piston (ram) to make contact with the trip lifting pawl with the driving force of the hammer.

Cause: Trips are operated by two methods:



Manual trip: A wire rope is connected to the trip and is directly controlled and positioned by the crane operator by controlling the rate of rotation of the winch that the wire rope is connected to. This method requires the crane operator to adjust the trip position while the hammer is running as the pile is being driven.

The common causes of dogging the trip in manual mode:

- Site personal tie-off the trip leaver safety rope so the trip is always engaged and while driving the pile the trip is lowered onto the engagement lug and engages the trip.
- Site personal tie off the trip leaver safety rope and there is an unexpected event, such as the hammer hitting the catch cap, resulting in the hammer body to jump which takes up any slack in the trip leaver safety rope, and the engagement lug engages the trip.
- The crane operator lowers the trip body too quickly so that there is a violent collision with the bottom part of the trips travel which may result in the trip engaging.

Hydraulic trip: A hydraulic cylinder(s) are connected to the hammer to move the trip up and down with the control of a hydraulic circuit within the crane or on a hydraulic power pack. This tripping method doesn't require adjustments while the pile is being driven. It is however recommended that the hydraulic cylinders are either fully extended if the hammer trip out leaver isn't able to swing away from the hammer body or fully retracted if the hammer trip out leaver is able to swing away from the hammer, as illustrated below.

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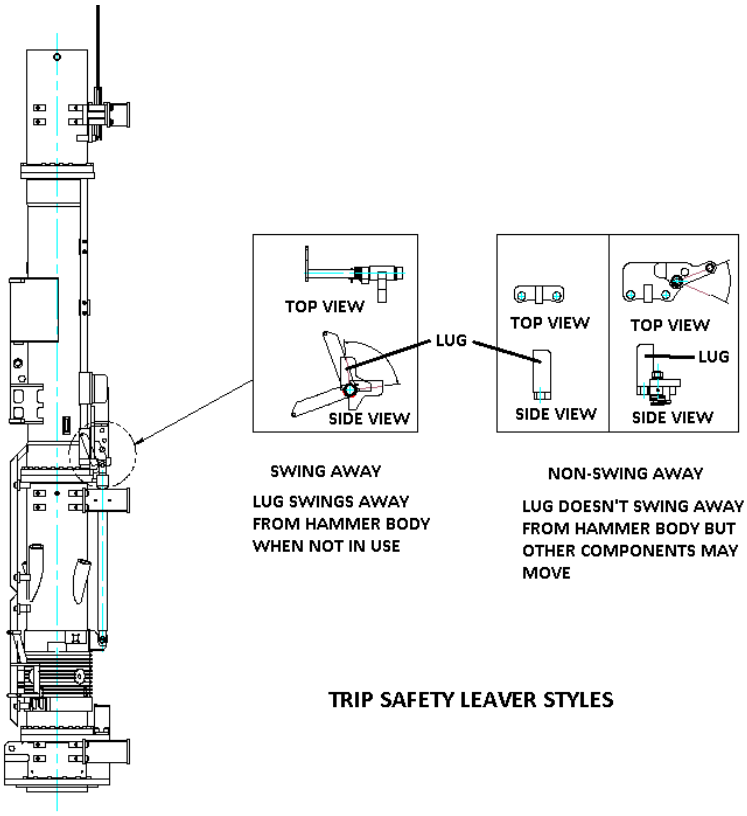

The common causes of dogging the trip in hydraulic mode:

- There is a hydraulic leak in the cylinders that isn't corrected before starting the hammer resulting in the trip lowering while in operation and the hammer model doesn't have a swing away trip safety lug or the safety leaver rope is tied off.
- The trip is lowered while the hammer is running and the hammer model doesn't have a swing away trip safety lug or the safety leaver rope is tied off.

Possible effects of dogging in the piston	
	Score marks to piston. Non-critical locations may not have an effect to hammer performance however damage around hammer features may require field fixes or possible machining to get the hammer running.

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	Internal trip components, which see the bulk of this force may require replacing. The pivoting holes which are round may become oval and will not pivot correctly. Pins also may also become bent and require replacing. The lifting pawl, which contacts the piston, can become deformed with the impact event. In some cases, damage may extend to trip body itself requiring sleeves to be installed in order to maintain pivot points and keep the trip functioning properly.