HYDRAULIC COMPACTOR/DRIVER

OPERATORS MANUAL

MODELS: C2D, C2C, C2
C3D
C4C, C4B, C4A, C4
C6C, C6B, C6
C8C, C8B, C8
C10C, C10
C12C, C12

"Use Genuine NPK Parts"

NPK ...attachments; designed, built and backed by NPK.

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CONTENTS

SAFETY

Safety notices in NPK Instruction Manuals follow ISO and ANSI standards for safety warnings:

DANGER (red) notices indicate an imminently hazardous situation which, if not avoided, **will result in death or serious injury**.

WARNING (orange) notices indicate a potentially hazardous situation which, if not avoided, **could result in death or serious injury.**

CAUTION (yellow) notices indicate a potentially hazardous situation, which, if not avoided, **may result in minor or moderate injury.**

ATTENTION (blue) notices in NPK Instruction Manuals are an NPK standard to alert the reader to situations which, if not avoided, **could result in equipment damage.**

1. Operators and service personnel must read, understand and comply with the ***NPK INSTRUCTION MANUAL.***
2. Keep personnel and bystanders clear of the COMPACTOR/DRIVER while in operation.
3. Do not operate the COMPACTOR/DRIVER without an impact resistant shield between the COMPACTOR/DRIVER and the operator.
4. The COMPACTOR/DRIVER must not be operated unless the operator is in full control of the carrier. Operate the COMPACTOR/DRIVER from the operator's seat only.
5. Match the COMPACTOR/DRIVER size to carrier according to NPK recommendations. See the CARRIER MACHINE COMPATIBILITY section of this manual.
6. Service personnel must be cautious handling pins and bushings when exchanging the bucket for the COMPACTOR/DRIVER. The carrier machine operator must move the stick or boom only when directed by service personnel.
7. If it is necessary to hammer the boom pins in or out, beware of flying metal chips. ***Eye protection be worn!***
8. Do not operate the COMPACTOR/DRIVER if the hydraulic oil temperature exceeds 180° F (80° C), or at higher than specified flow rates.
9. Be especially cautious around hydraulic lines. Hydraulic oil can be extremely ***HOT! Avoid skin contact with hydraulic oil! It can cause severe burns!***
10. Protect hands and body from hydraulic fluids under pressure. Escaping high pressure fluid can penetrate the skin, causing serious injury. Avoid the hazard by relieving the pressure form the hydraulic system before disconnecting any lines. Search for leaks with a piece of cardboard or other object. ***If an accident occurs, seek medical attention immediately! Hydraulic fluid injected into the skin must be surgically removed immediately or gangrene may result!***

SAFETY

11. Make daily visual inspections of all fasteners, boom pins, hoses, etc.
12. Do not make any alterations to the COMPACTOR/DRIVER without authorization from NPK Engineering.
13. Use only NPK supplied replacement parts. NPK specifically disclaims any responsibility for bodily injury or COMPACTOR/DRIVER damage that results from the use of parts not sold or approved by NPK.
14. Be careful when you torque fasteners. An overstressed or damaged component may fail.
15. Use the proper lifting equipment and tools when handling or servicing the COMPACTOR/DRIVER or components.
16. Important safety and operating decals are included with each COMPACTOR/DRIVER and HYDRAULIC INSTALLATION KIT. Keep them clean and visible. NPK will replace decals free of charge as needed.

FORWARD

This manual has been written to give the necessary instructions for operating, maintaining, and servicing the NPK Compactor/Driver. Read this manual before start-up.

For help with any problems encountered, or additional information, contact your NPK authorized Distributor.

Use replacement parts sold by NPK only. NPK is not responsible for failures resulting from alterations not approved by NPK or substitution of parts not sold by NPK. Do not operate the Compactor/Driver underwater without instructions from NPK Engineering.

COMPACTOR/DRIVER APPLICATIONS

The excavator mounted Compactor/Driver is a mobile, self-contained unit that operates anywhere a boom can reach. This versatile attachment compacts in the trench, around and over pipe, or reaches to the top of piling and sheeting for driving or extracting in the toughest of conditions and in rough terrain areas. The mounted Compactor keeps the workers out of the trench and safe from cave-ins. Even slopes that are too steep for a conventional roller can be easily reached for compaction.

APPLICATIONS INCLUDE:

- *HIGH PRODUCTION SOIL AND AGGREGATE COMPACTION.*
- *DEEP TRENCH COMPACTION, AS DEEP AS A BUCKET CAN DIG.*
- *SLOPE COMPACTION.*
- *WASTE COMPACTION AT TRANSFER STATIONS, ETC.*
- *BREAKING UP FROZEN MATERIAL, SUCH AS COAL, SALT, ETC.*
- *DRIVING PILE, SHEET, FENCE POSTS, GUARDRAIL POSTS, ETC.*
- *EXTRACTION OF PILING AND SHEETING.*
- *COMPACTING OR DRIVING ANYWHERE A BOOM CAN GO . . . AND MAN CANNOT.*

MAINTENANCE

STANDARD PRACTICES

ATTENTION

Maintenance of and repairs to the COMPACTOR/DRIVER should be performed by an experienced service technician, thoroughly familiar with all standard practices and procedures, and most importantly, all safety precautions. The following is a review of common standard practices to be followed when working with hydraulic equipment, and is not meant to be all-inclusive. Rather, this review is presented as a reminder as to some of the unique characteristics of hydraulic equipment.

- The prevention of foreign contaminant damage is critical when working with hydraulic equipment. Protect exposed holes and parts to guard against entry of contaminants. Install metal or plastic plugs/caps where applicable to prevent entry of debris into the hydraulic system.
- Mark the location and position of mating parts as an aid to re-assembly. Mark corresponding parts uniquely to reflect their relationship, including proper location, position, orientation, and/or alignment.

DO:

- During assembly, observe all markings made during disassembly, and all corresponding features of mating parts to ensure proper location, position, orientation and alignment.
- During disassembly of a sub-assembly, place removed components on a clean, dry surface, in proper relative position as an aid in re-assembly.
- Always inspect threaded areas on components. Repair or replace as required. Never apply uncured thread adhesive to a fastener that has cured adhesive on it. Clean the fastener and the threaded bore. A tap and die may be helpful for this task. Be sure to remove loose debris from the threaded bore.
- Use care to avoid scratches, nicks, dents, or other damage to machined surfaces of mating components.
- When securing a component, always tighten cap screws gradually in an opposing pattern, applying the specific torque.
- Grease can be used to temporarily hold a part in place while the abutting part is placed into position.
- Always use common sense and exercise standard safety precautions when working with all tools and equipment required to maintain, repair or troubleshoot the COMPACTOR/DRIVER.

CARRIER COMPATIBILITY

These carrier weight ranges are intended as a guideline only. Other factors, such as stick length, counterweights, undercarriage, etc., must be taken into consideration.

⚠ CAUTION

Mounting a Compactor that is too heavy for the carrier machine is inefficient. The result is an inadequate amount of downforce which can be dangerous and can damage the carrier. Verify the carrier stability with the Compactor before transport or operation. Mounting a Compactor that is too small for the carrier machine can damage the unit and void the Warranty.

Consult NPK, if there is uncertainty whether the compactor model is compatible.

COMPACTOR/DRIVER MODEL	RECOMMENDED CARRIER WEIGHT	
	lb.	*(kg)*
C2D, C2C, C2	5,000 - 12,000	*(2,300 - 5,500)*
C3D	7,000 - 18,000	*(3,220 - 8,250)*
C4C, C4B, C4A, C4	10,000 - 25,000	*(4,500 - 11,500)*
C6C, C6B, C6	16,000 - 42,000	*(7,000 - 19,000)*
C8C, C8	30,000 - 65,000	*(14,000 - 29,500)*
C8B	30,000 - 75,000	*(14,000 - 34,400)*
C10	35,000 - 60,000	*(15,875 - 27,250)*
C10C, C12	60,000 - 100,000	*(27,000 - 45,000)*
C12C	80,000 - 140,000	*(36,000 - 63,500)*

(Specifications subject to change without notice.)

SPECIFICATIONS

MODEL	CYCLES PER MINUTE	OIL FLOW (standard)		OIL FLOW (low flow option)		OIL FLOW (high flow option)	
		gpm	*(lpm)*	gpm	*(lpm)*	gpm	*(lpm)*
C2D	2,400	13	*(49)*	CONTACT NPK		N/A	
C2C	2,200	13	*(49)*	10	*(38)*	N/A	
C2	2,200	15	*(56)*	10	*(38)*	N/A	
C3D	2,200	16	*(61)*	N/A		N/A	
C4C	2,100	22	*(83)*	CONTACT NPK		N/A	
C4B	2,200	22	*(83)*	16	*(61)*	30	*(114)*
C4A/C4	2,200	22	*(83)*	15	*(56)*	N/A	
C6C	2,200	33	*(125)*	25.5	*(97)*	N/A	
C6B	2,200	33	*(125)*	28	*(106)*	40	*(151)*
C6	2,200	33	*(125)*	N/A		40	*(151)*
C8C	2,200	43	*(160)*	CONTACT NPK		N/A	
C8B	2,200	43	*(160)*	33	*(125)*	55	*(210)*
C8	2,200	40	*(151)*	N/A		55	*(210)*
C10C	2,200	51	*(210)*	CONTACT NPK		N/A	
C10**	N/A	N/A	N/A	N/A		N/A	
C12C	2,200	70	*(265)*	CONTACT NPK		N/A	
C12	2,400	55	*(210)*	40	*(151)*	62	*(235)*

**Contact NPK for assistance at (440) 232-7900

MODEL	IMPULSE FORCE		OPERATING PRESSURE$_1$		RELIEF VALVE PRESSURE SETTING$_2$	
	lbf	*(kgf)*	psi	*(bar)*	psi	*(bar)*
C2D*	3,500	*(1,590)*	1500-2000	*(105-140)*	2500	*(170)*
C2C*	3,500	*(1,590)*	1500-2000	*(105-140)*	2500	*(170)*
C2	3,500	*(1,590)*	1500-2000	*(105-140)*	2500	*(170)*
C3D*	6,000	*(2,720)*	1700-2200	*(117-150)*	2500	*(170)*
C4C*	7,800	*(3,550)*	1700-2200	*(117-150)*	2600	*(180)*
C4B	7,800	*(3,550)*	1700-2200	*(117-150)*	2600	*(180)*
C4A, C4	7,800	*(3,550)*	1700-2200	*(117-150)*	2600	*(180)*
C6C*	16,000	*(7,300)*	1800-2300	*(125-160)*	2600	*(180)*
C6B	16,000	*(7,300)*	1800-2300	*(125-160)*	2600	*(180)*
C6	16,000	*(7,300)*	1800-2300	*(125-160)*	2600	*(180)*
C8C*	24,000	*(11,000)*	2000-2500	*(140-170)*	2600	*(180)*
C8B	24,000	*(11,000)*	2000-2500	*(140-170)*	2600	*(180)*
C8	24,000	*(11,000)*	2000-2500	*(140-170)*	2600	*(180)*
C10C*	34,000	*(15,450)*	2000-2500	*(140-170)*	2600	*(180)*
C10**	N/A	N/A	N/A	N/A	N/A	N/A
C12C*	45,000	*(20,420)*	2000-2500	*(140-170)*	2600	*(180)*
C12	38,000	*(17,300)*	2400-2800	*(165-195)*	3000	*(207)*

*****Denotes NPK "C" and "D" model compactor/drivers that have built in relief valves.

The carrier circuit relief valve settings should be a minimum of 200 psi *(14 bar)* above the compactor/driver relief settings.

"A" and "B" model NPK compactor/drivers rely on the carrier's circuit relief valve.

******Call NPK for assistance at (440) 232-7900.

1. Operating pressures shown are with a standard hydraulic motor. Operating pressures will be different with optional hydraulic motors.
2. Relief pressure setting shown is for a standard hydraulic motor. For a relief with different motor options, contact NPK at (440) 232-7900.

(Specifications subject to change without notice.)

SPECIFICATIONS

MODEL	**WEIGHT** (WITHOUT TOP BRACKET)							
	FIXED TOP STANDARD BASE		**SWIVEL TOP STANDARD BASE**		**FIXED TOP NARROW BASE**		**SWIVEL TOP NARROW BASE**	
	lb.	***(kg)***	**lb.**	***(kg)***	**lb.**	***(kg)***	**lb.**	***(kg)***
C2D	390	*(177)*	N/A		N/A		N/A	
C2C	380	*(170)*	N/A		N/A		N/A	
C2	380	*(170)*	N/A		N/A		N/A	
C3D	700	*(318)*	800	*(363)*	N/A		N/A	
C4C	800	*(363)*	960	*(436)*	870	*(395)*	920	*(418)*
C4B	850	*(385)*	875	*(400)*	N/A		N/A	
C4A/C4	850	*(385)*	875	*(400)*	N/A		N/A	
C6C	1535	*(696)*	1715	*(778)*	N/A		N/A	
C6B	1450	*(660)*	1500	*(680)*	N/A		N/A	
C6	1500	*(680)*	N/A		N/A		N/A	
C8C	2100	*(953)*	2325	*(1056)*	N/A		N/A	
C8B	1950	*(890)*	2000	*(910)*	N/A		N/A	
C8	2000	*(910)*	N/A		N/A		N/A	
C10C	3400	*(1542)*	3515	*(1640)*	N/A		N/A	
C10**	N/A		N/A		N/A		N/A	
C12C	4000	*(1814)*	4475	*(2030)*	N/A		N/A	
C12	4040	*(1835)*	4120	*(1870)*	N/A		N/A	

**Contact NPK for assistance at (440) 232-7900.

MODEL	HEIGHTH		WIDTH		INSIDE BRACKET WIDTH$_3$	
	in.	***(mm)***	**in.**	***(mm)***	**in.**	***(mm)***
C2D	28	*(711)*	12	*(305)*	7	*(178)*
C2C	28	*(711)*	14	*(356)*	7	*(178)*
C2	25	*(635)*	14	*(356)*	7	*(178)*
C3D	29	*(737)*	17	*(432)*	10-1/4	*(260)*
C4C	30	*(762)*	23	*(584)*	10-1/4	*(260)*
C4B	30	*(762)*	24	*(610)*	10-1/4	*(260)*
C4A/C4	30	*(762)*	24	*(610)*	10-1/4	*(260)*
C6C	39	*(991)*	29	*(736)*	12-1/2	*(318)*
C6B	39	*(991)*	29	*(736)*	12-1/2	*(318)*
C6	39	*(991)*	29	*(736)*	12-1/2	*(318)*
C8C	45	*(1143)*	34	*(864)*	14-9/16	*(370)*
C8B	45	*(1143)*	34	*(864)*	14-9/16	*(370)*
C8	45	*(1143)*	34	*(864)*	14-9/16	*(370)*
C10C	50	*(1270)*	40	*(1016)*	Varies with carrier	
C10**	N/A	*N/A*	34	*(864)*	N/A	N/A
C12C	55	*(1397)*	45	*(1143)*	Varies with carrier	
C12	47	*(1195)*	45	*(1143)*	14-9/16	*(370)*

**Contact NPK for assistance at (440) 232-7900.

3. Options are available for special applications.

(Specifications subject to change without notice.)

SPECIFICATIONS

MODEL	SWIVEL FEATURE	STANDARD BASEPLATE				NARROW BASEPLATE			
		Dimensions		Compaction Area		Dimensions		Compaction Area	
		in.	*(cm)*	sq. ft.	*(sq m)*	in.	*(cm)*	sq. ft.	*(sq m)*
C2D	N/A	12 x 25	*(32 x 63.5)*	2.1	*(0.2)*	N/A		N/A	
C2C	N/A	14 x 22	*(36 x 56)*	2.1	*(0.2)*	N/A		N/A	
C2	N/A	14 x 22	*(36 x 56)*	2.1	*(0.2)*	N/A		N/A	
C3D	OPTIONAL	17 x 28	*(43 x 69)*	3.3	*(0.3)*	N/A		N/A	
C4C	OPTIONAL	23 x 34	*(58 x 86)*	5.4	*(0.5)*	18 x 34	*(46 x 86)*	4.3	*(0.4)*
C4B	OPTIONAL	24 x 34	*(61 x 86)*	5.7	*(0.5)*	N/A		N/A	
C4A/C4	OPTIONAL	24 x 34	*(61 x 86)*	5.7	*(0.5)*	N/A		N/A	
C6C	OPTIONAL	29 x 40	*(74 x 102)*	8.1	*(0.75)*	SP. ORDER			
C6B	OPTIONAL	29 x 40	*(74 x 102)*	8.1	*(0.75)*	N/A		N/A	
C6	STANDARD	29 x 40	*(74 x 102)*	8.1	*(0.75)*	N/A		N/A	
C8C	OPTIONAL	34 x 46	*(86 x 117)*	10.9	*(1.0)*	SP. ORDER			
C8B	OPTIONAL	34 x 46	*(86 x 117)*	10.9	*(1.0)*	N/A		N/A	
C8	STANDARD	34 x 46	*(86 x 117)*	10.9	*(1.0)*	N/A		N/A	
C10C	OPTIONAL	40 x 52	*(102 x 132)*	14.5	*(1.3)*	SP. ORDER			
C10**	OPTIONAL	34 x 46	*(86 x 117)*	10.9	*(1.0)*	N/A		N/A	
C12C	OPTIONAL	45 x 58	*(114 x 147)*	18.1	*(1.7)*	SP. ORDER			
C12	OPTIONAL	40 x 55	*(101 x 140)*	15.2	*(1.36)*	N/A		N/A	

(Specifications subject to change without notice.)

COMPACTOR/DRIVER STRUCTURE

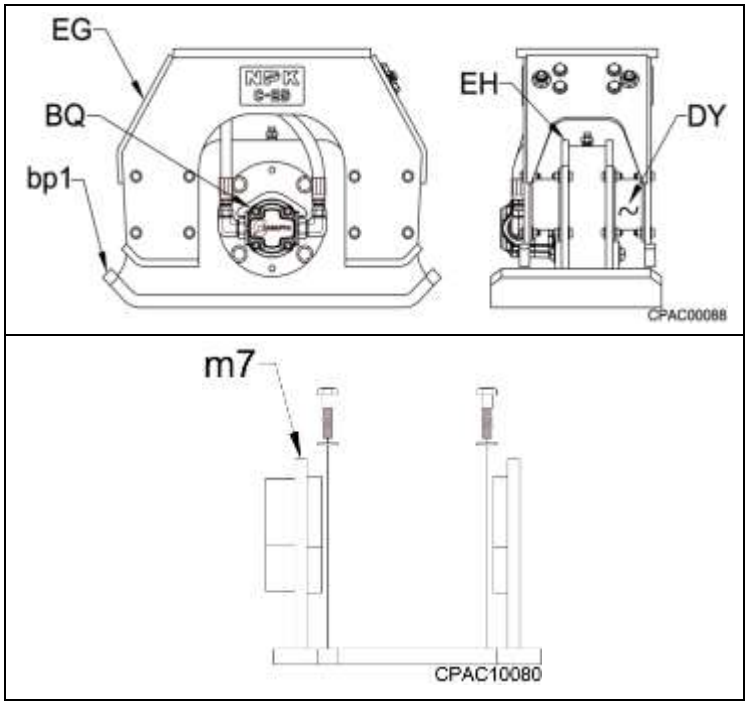
C2D THROUGH C12C COMPACTOR/DRIVERS

The C2D through C12C Compactor/Drivers consist of a top bracket, an upper frame and a lower frame. The C2D Compactor has a fixed top bracket only. The C3D, C4C, C6C, C8C, C10C, and C12C Compactor/Drivers are available with fixed or swivel top brackets.

The C2D, C3D, C4C, C6C, and C8C upper frames are mounted to the lower frames with four bolt-on rubber mounts. C10C and C12C models use eight bolt-on rubber mounts. The rubber mounts reduce the amount of vibration being transmitted to the carrier.

The lower frame contains an eccentric weight suspended on roller bearings and spun by a hydraulic motor. The baseplate of these units is a welded part of the lower frame.

The upper frame contains a bolt-on hydraulic manifold (B, C, and D Series only).

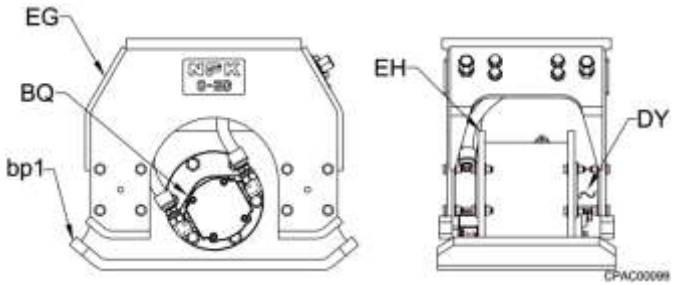


MODEL C2D

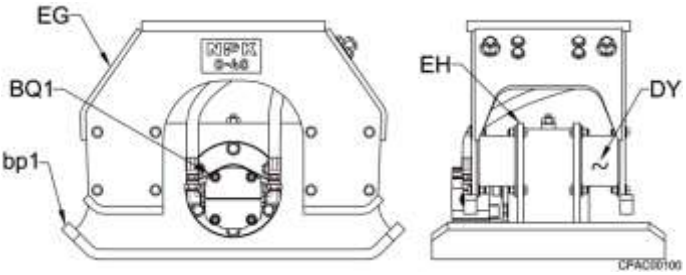
ITEM	DESCRIPTION
bp1	BOTTOM PLATE
BQ	HYDRAULIC MOTOR
DY	RUBBER MOUNT
EG	UPPER FRAME
EH	LOWER FRAME
m7	TOP BRACKET

COMPACTOR/DRIVER STRUCTURE

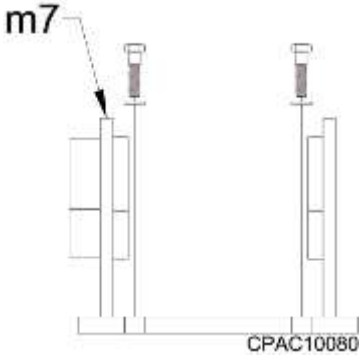
C2D THROUGH C12C COMPACTOR/DRIVERS



MODEL C3D



MODEL C4C



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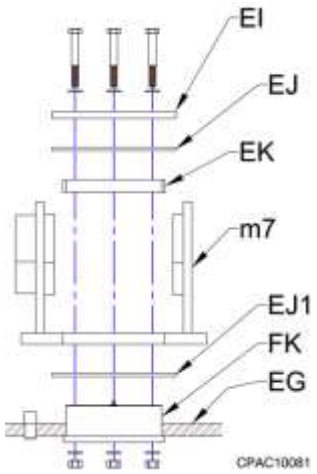
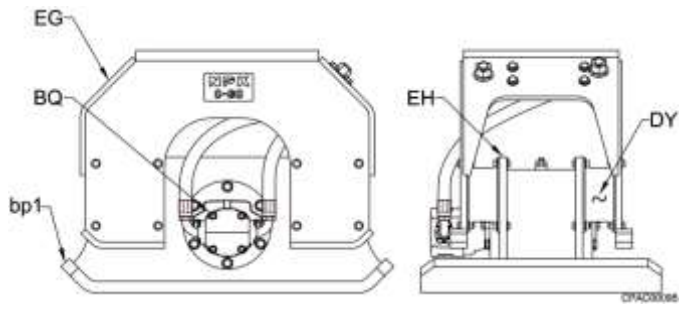


SWIVEL

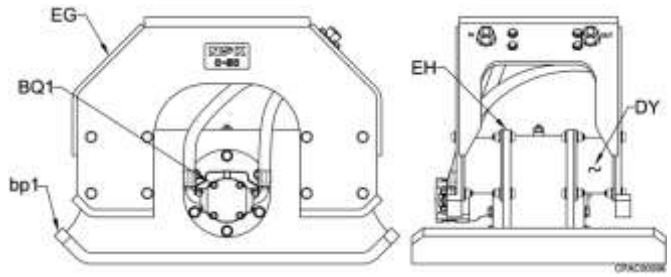
ITEM	DESCRIPTION
bp1	BOTTOM PLATE
BQ	HYDRAULIC MOTOR C3D
BQ1	HYDRAULIC MOTOR C4C
DY	RUBBER MOUNT
EG	UPPER FRAME
EH	LOWER FRAME
EI	THRUST COVER
EJ	UPPER THRUST PLATE
EJ1	LOWER THRUST PLATE
EK	THRUST BEARING
FK	SWIVEL HUB (bolt-on)
m7	TOP BRACKET

COMPACTOR/DRIVER STRUCTURE

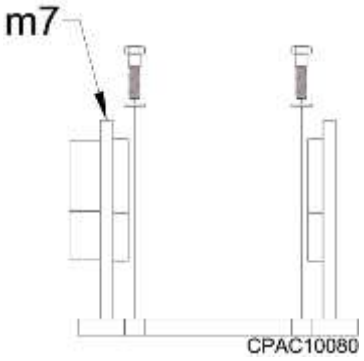
C2D THROUGH C12C COMPACTOR/DRIVERS



MODEL C6C



MODEL C8C



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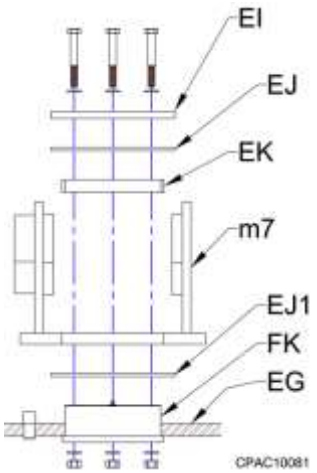
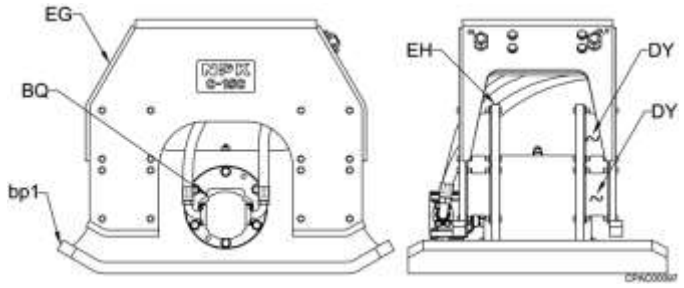


SWIVEL

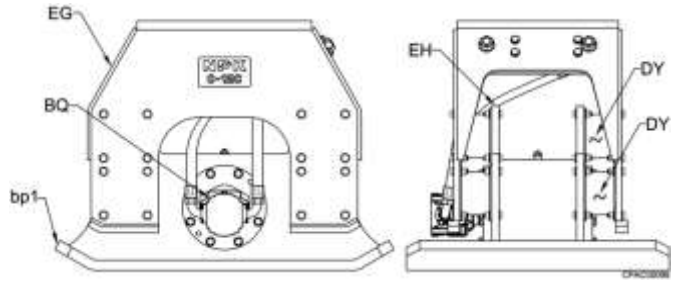
ITEM	DESCRIPTION
bp1	BOTTOM PLATE
BQ	HYDRAULIC MOTOR (C6)
BQ1	HYDRAULIC MOTOR (C8)
DY	RUBBER MOUNT
EG	UPPER FRAME
EH	LOWER FRAME
EI	THRUST COVER
EJ	UPPER THRUST PLATE
EJ1	LOWER THRUST PLATE
EK	THRUST BEARING
FK	SWIVEL HUB (weld-on)
m7	TOP BRACKET

COMPACTOR/DRIVER STRUCTURE

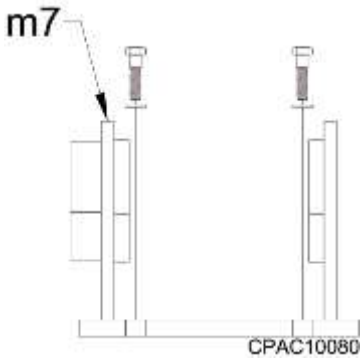
C2D THROUGH C12C COMPACTOR/DRIVERS



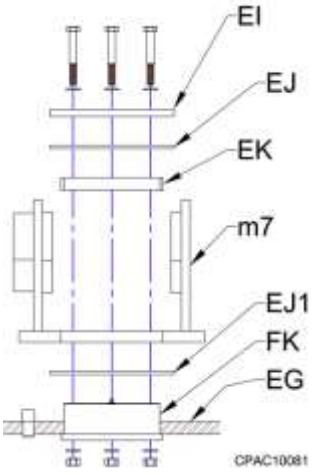
MODEL C10C



MODEL C12C



FIXED



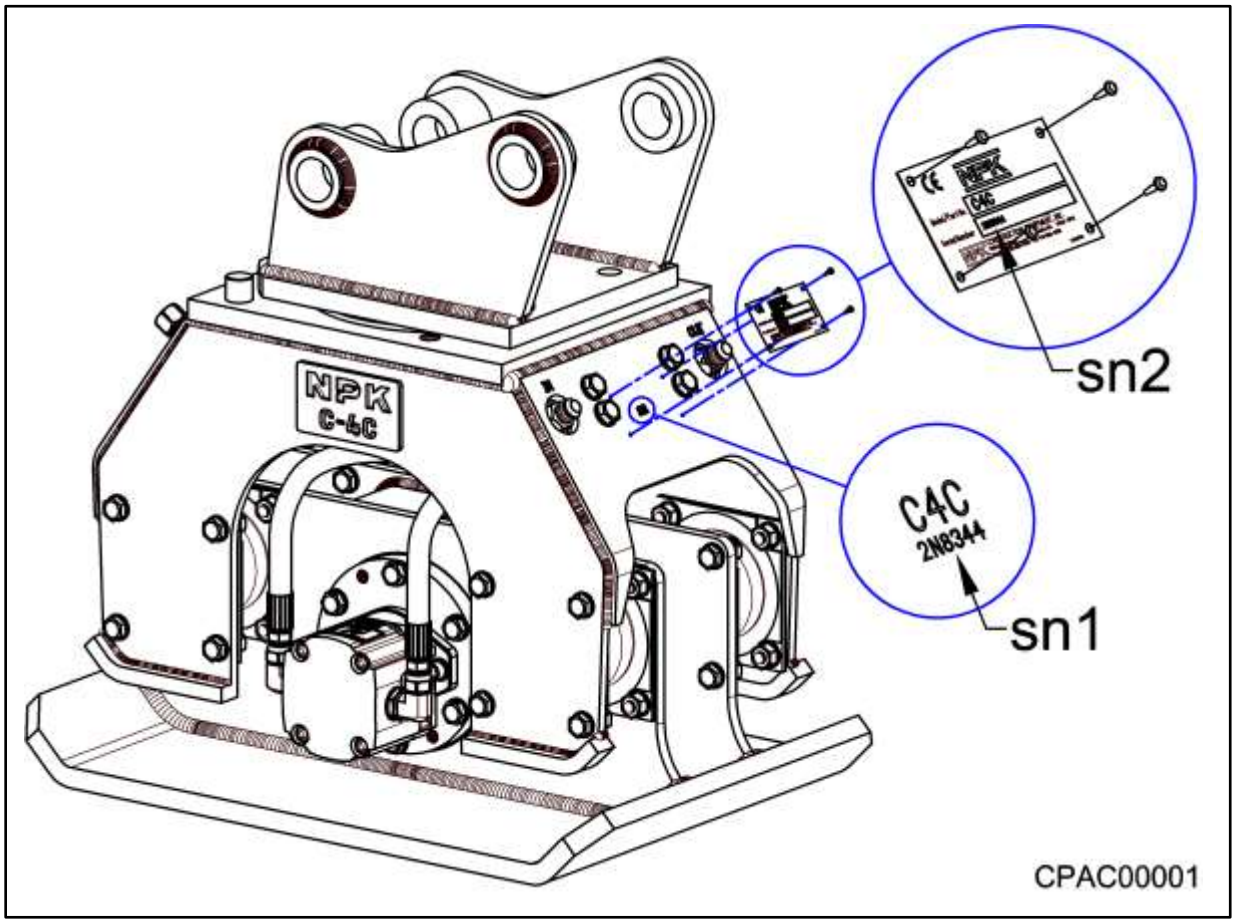
SWIVEL

ITEM	DESCRIPTION
bp1	BOTTOM PLATE
BQ	HYDRAULIC MOTOR
DY	RUBBER MOUNT
EG	UPPER FRAME
EH	LOWER FRAME
EI	THRUST COVER
EJ	UPPER THRUST PLATE
EJ1	LOWER THRUST PLATE
EK	THRUST BEARING
FK	SWIVEL HUB (weld-on)
m7	TOP BRACKET

COMPACTOR/DRIVER SERIAL NUMBER LOCATION

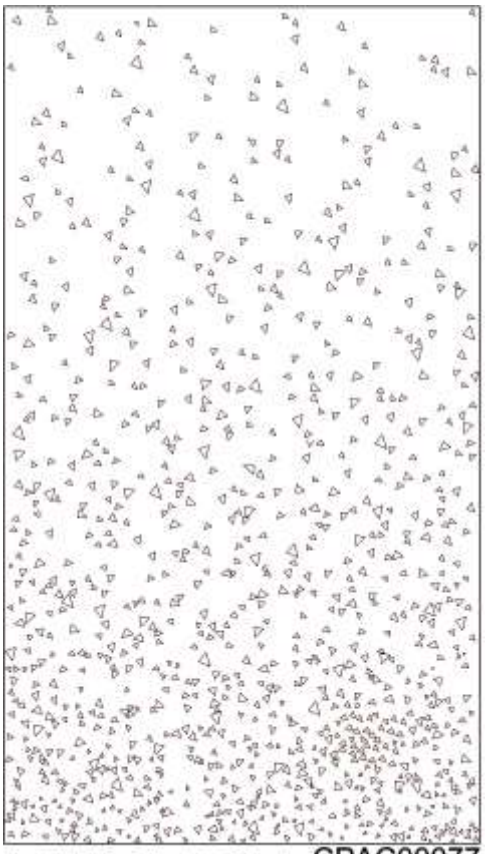
The serial number of your unit is required any time that you are placing a parts order or requiring technical assistance. Failure to use the serial number when ordering parts, may result in receiving the incorrect parts, resulting in additional cost and down time. The serial number will be comprised of the following sequence of numbers and letters: 0N-0000. *(Units that shipped before July of 1999, will have a five-digit number stamped into the upper frame.)*

The location described below is between the inlet and outlet hydraulic ports on the upper frame.



The serial number tag (sn2) can be found on the upper frame assembly. Additionally, the serial number (sn1) is stamped below the serial number tag on the upper frame assembly.

UNDERSTANDING COMPACTION



Whenever the earth is disturbed, it loses its original density. In order to regain that density, it must be manipulated by some mechanical means.

Compaction is the reduction in soil volume that occurs when force is applied to it. The application of external compressive forces increases the soil density or unit weight by mechanically rearranging and moving soil particles closer to each other, and forcing out the air that has been trapped between these particles. Increasing the density of the soil improves the ability of the soil to support a load and reduces the possibility of settling. This is particularly important when loose fill is placed in a trench or any other open area. Non-compacted fill will slowly settle, causing a void and allowing the surface to fall into the void.

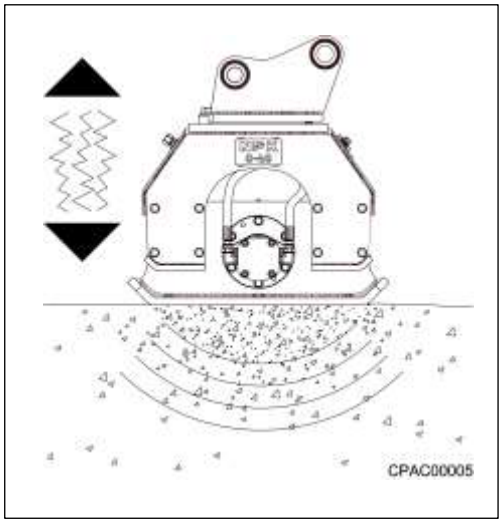
The extent to which a soil can be compacted depends on three major factors:

1. The type of soil and its compactability.
2. The moisture content of the soil.
3. The type of compaction effort required, that is pressing, ramming, or vibration.

COMPACTION FORCES

Amplitude. Total vertical distance the vibrating baseplate or roller travels is called the amplitude. The amplitude of any given machine will vary depending on soil conditions. The amplitude will gradually increase as the soil becomes denser and more compacted. The amplitudes of a mounted compactor are substantially greater than other machine types.

The high amplitudes of NPK Compactors are especially effective on materials which require a high compactive effort, such as coarse rock fill and dry clay soils.

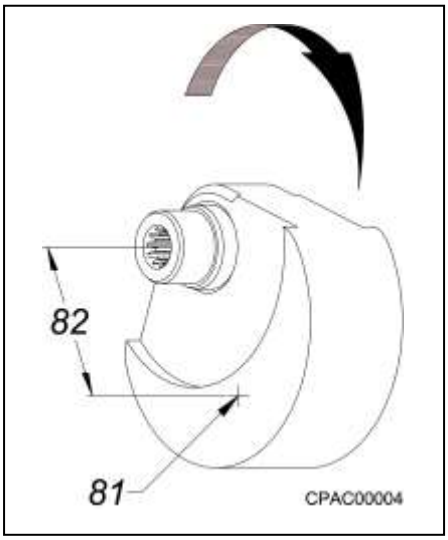


Static Pressure. Static pressure is the pressing force the machine plate or foot exerts on the soil. The forces are from the weight of the machine; and from the carrier if the machine is a boom mounted compactor.

The downforce produced from the weight of the carrier machine is a principle reason mounted compactors significantly outperform rammers, jumping jacks, walk behind plate compactors and even much larger self-propelled compactors.

Frequency. Frequency is the number of cycles of the vibrating mechanism per minute. Each cycle corresponds to one revolution of an eccentric mass.

Centrifugal force (Impulse force). A high-speed hydraulic motor rotates an eccentric mass to produce impulse force. Impulse force is a function of the dynamic parameters of eccentric moment and vibrational frequency.



81 = Center of Gravity
82 = Centerline of Rotation to the Center of Gravity

Impulse force = eccentric moment x frequency^2 x constant
= wr x rpm^2 x .0000284

SOIL MATERIAL

SOIL TYPES

The unconsolidated material that is lying above the bedrock is soil. Specifically, soil is made up of disintegrated rocks and other material that have been broken down into smaller pieces by nature's mechanical and chemical processes. This material is available to the contractor as building material. Soils can be classified into three groups – granular, clays, and organic.

Granular. If the breakdown process from solid bedrock was mechanical, such as by water or wind erosion, glacial action, freezing and thawing, etc., the soil will have the same composition as the base rock from which it came. Granular soil particles are non-cohesive, sand or gravel consisting of grains as small as .002 inches (*.05 mm*).

Clay. If the breakdown included some chemical reactions due to heat, pressure, and moisture over long periods of time, the composition of the base rock changes and tiny plate-like or scale shaped particles result. These very fine particles are regarded as a cohesive, clay soil.

Organic. Plant growth also contributes to soil formation. Decayed plants form loam or peat, which is desirable for agricultural purposes. This type of soil has a spongy residue that holds water and air, which is very detrimental for construction applications.

SOIL MIXING

Because of all the varying soil constituents, there is a wide variation of soils. When the soil particle size range extends over more than two size classes, the soil is termed a mixed soil. And this is common, since most soils in the field are mixtures of various sizes of granular and cohesive material. In fact, soil with the highest bearing capacity contains sufficient quantities of gravel and sand to contribute to high internal friction and enough fine-grained soil such as clay to provide adequate cohesion.

Mixing soils at the job is closely allied with moisture. It is a key step that makes compaction easy or difficult.

SOIL MATERIAL

SOIL PROPERTIES

The following terms refer to properties and characteristics of soil materials. Knowledge of these industry terms will provide a better understanding of compaction.

Compressibility. Compressibility is the reduction in soil volume that occurs when force is applied to it. Compressibility is achieved as air and water are expelled from the voids between the soil particles forcing the particles closer together, thus occupying less volume.

Cohesion. A soil is cohesive or non-cohesive depending on the degree to which the particles stick to one another. The inner-particle molecular attraction of one particle for another, increases with a decrease in particle size. Granular materials have very low cohesion because the particles are large and rough. Clay particles are small and smooth and have high cohesion.

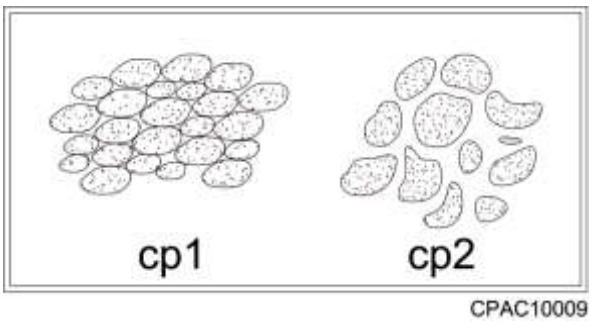


Fig. 1 – COHESION	
cp1	HIGH COHESION
cp2	LOW COHESION

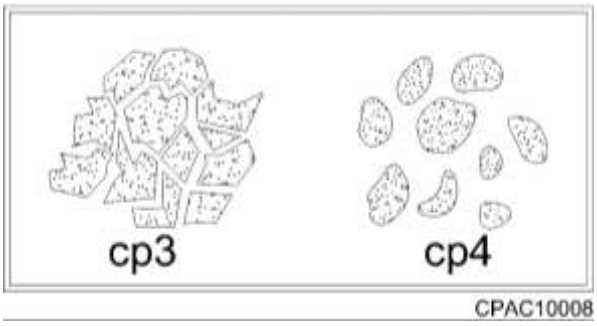


Fig. 2 – INTERNAL FRICTION	
cp3	HIGH FRICTION
cp4	LOW FRICTION

Shear Resistance. Soil particle resistance to movement when pressure, impact or vibration is applied is shear resistance. The resistance comes from the friction between the soil particles when they slide by each other. Therefore, the higher the shear resistance the greater the force required to compact the soil. Clay has a high shear resistance, while granular material has a low shear resistance.

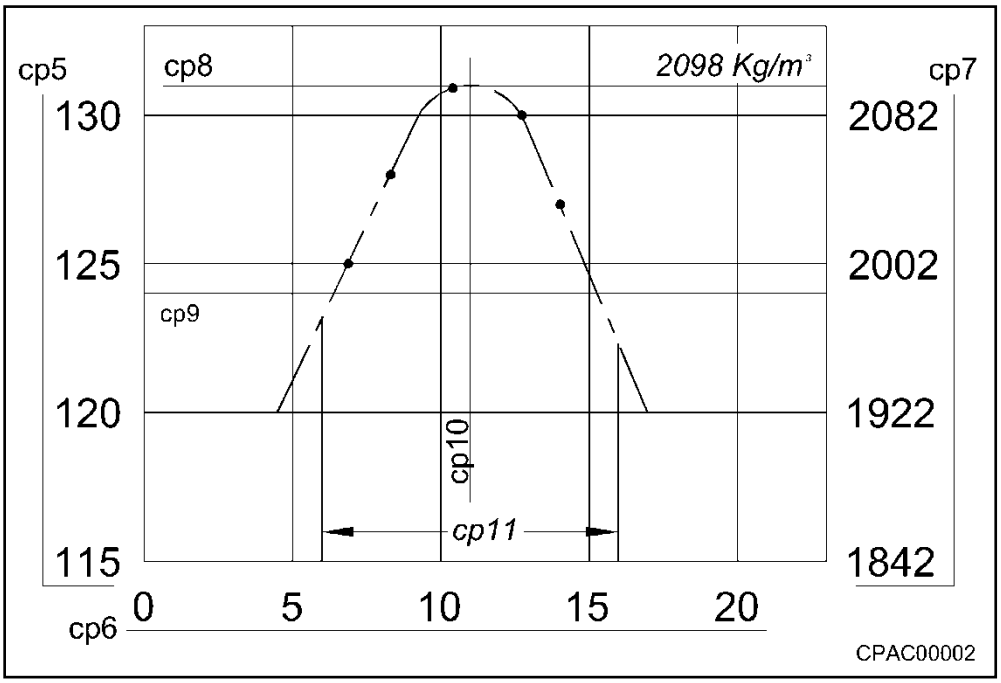
Elasticity. As the term implies, elasticity is a soil's ability to return in part to its original form after a compressive load is removed. Soils of this type are very undesirable in construction and road building. For example, a continually flexing road surface will fatigue and break under traffic loads.

SOIL DENSITY TESTING

LABORATORY TESTS

A lab procedure called the Proctor Test measures a soil sample to determine the moisture content and whether or not compaction is being achieved. There are several ways of testing for soil density, which were originally developed by R. R. Proctor in 1933. The Proctor method of compaction control established the relationship between the soil related to a condition called optimum moisture content.

Moisture Content. Each soil type has an optimum moisture content at which maximum density can be achieved with the smallest amount of compactive forces. The optimum moisture for a given soil is established in the laboratory. The correct amount of water is necessary in order for the soil particles to slide by each other in the compaction process. The water, in effect, acts as a lubricant. If there is too much water in the soil, the water will take up space between the particles and not allow them to bond together. The graph below illustrates the effect of moisture on soil density.



cp5	Dry Density – Lbs. per Cu. Ft.
cp6	Moisture - % of Dry Weight
cp7	Dry Density – Kg. per Cu. Meter
cp8	Max. Density 131 Lb. per Cu. Ft.
cp9	95% of Max. Density
cp10	Optimum Moisture – 11%
cp11	Compacting Moisture Range

As the moisture content is increased to the optimum percentage, the density will increase. If too much moisture is added, the soil's density will decrease.

SOIL DENSITY TESTING

Standard Proctor Test. A Standard Proctor soil test is conducted as follows:
A soil sample is taken from the job location and placed in a container equal to 1/30 cubic foot. A 5-1/2 pound weight with a striking face of 3.1 square inches is dropped 12 inches for 25 blows on each of the three equal layers. The soil material is then weighed, less the mold, and recorded as wet weight/cubic ft. The material is then oven dried for 12 hours in order to evaluate the water content.

Modified Proctor Test. The Modified Proctor test is done in much the same way as the Standard Proctor test, except a 10 pound hammer is used and dropped from a distance of 18 inches for 25 blows. The material is placed in five equal layers in a container 1/30 cu. ft. The compaction effort produced is 56,200 foot pounds while the Standard Proctor test produces 12,400 foot pounds. The Modified test is normally used in testing materials for higher shearing strength, which would likely be used in supporting heavier loads.

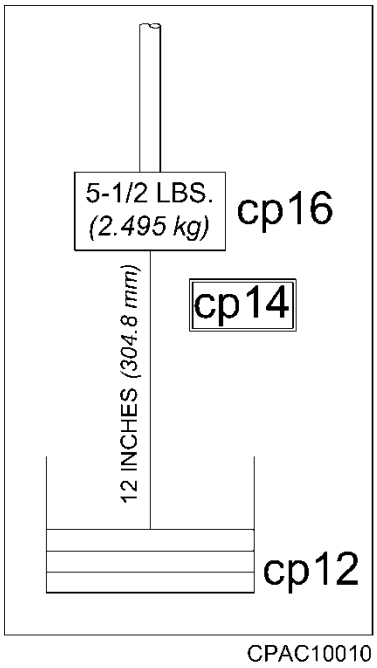


Fig. 3

STANDARD PROCTOR TEST

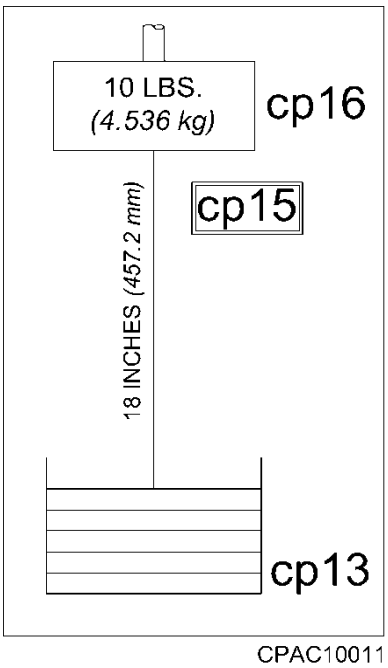


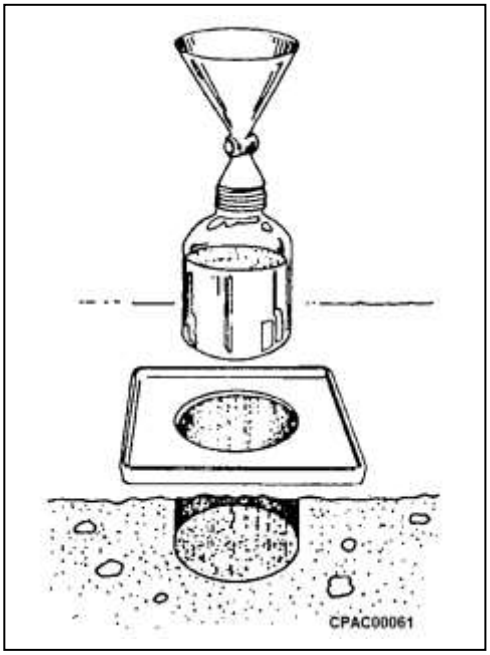
Fig. 4

MODIFIED PROCTOR TEST

cp12	Soil Sample 1/30 cu. ft. – 3 layers
cp13	Soil Sample 1/30 cu. ft. – 5 layers
cp14	Compaction Energy 12,400 ft. lbs. (16,740 Nm)
cp15	Compaction Energy 56,200 ft. lbs. (75,870 Nm)
cp16	25 Blows per Layer

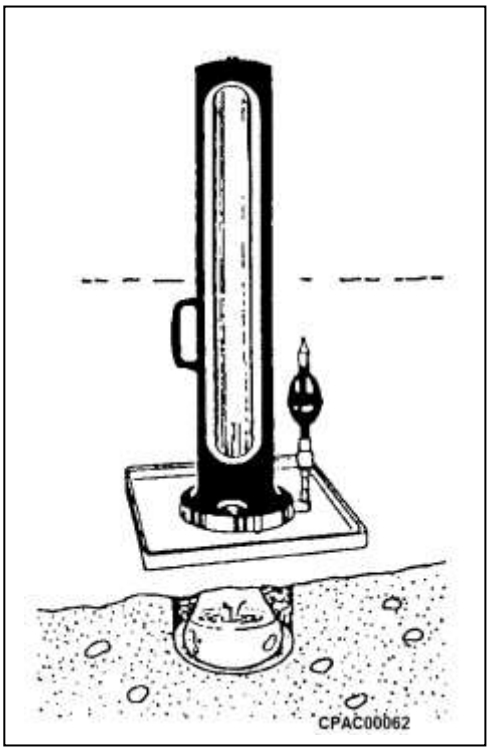
SOIL DENSITY TESTING

FIELD TESTS



Sand Cone Test.

1. A hole is dug using a density plate as a guide.
2. The soil sample is removed from the shallow density hole and preserved in a closed container to prevent loss of moisture from the sample.
3. Sand of a known weight and volume is used to fill the hole using the sand cone apparatus. The volume of the density hole is then determined by knowing the bulk density of the sand and the amount of sand required to fill the hole.
4. The moisture content of the density sample is determined.
5. From this data the dry density or dry weight per cubic foot of the soil removed from the hole can be calculated.



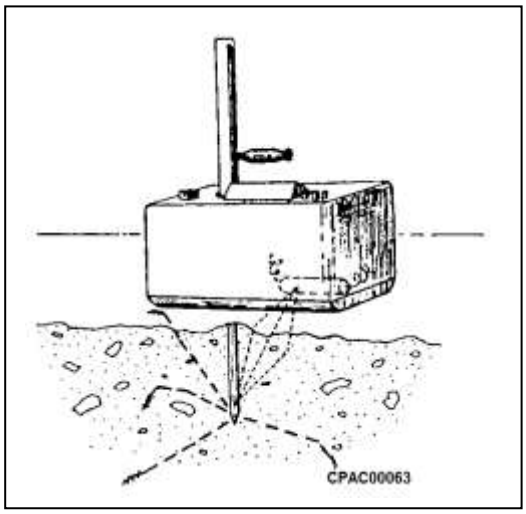
Water Balloon Test.

1. This is a diagram of the apparatus used to demonstrate the Rubber Balloon test method. Essentially, the apparatus consists of a calibrated graduated glass cylinder which holds water, a balloon attached to the cylinder, and an assembly for applying pressure.
2. At the test location, the technician digs a hole, using a density plate as a guide. This density hole will be approximately four inches in diameter and about six inches deep.
3. The loose material taken from the hole is placed in a container for later determination of its weight and moisture content for the density calculations.
4. Using this apparatus, the operator takes the initial reading and pumps the water into the balloon, which fills the hole. Then the final reading is taken to determine the actual volume of the density hole.
5. We must know the volume of the hole, the weight of the sample material removed, and its moisture content. Then we can determine the density of the sample material and thus check compliance with job specifications.

SOIL DENSITY TESTING

Nuclear Testing for Soil Density.

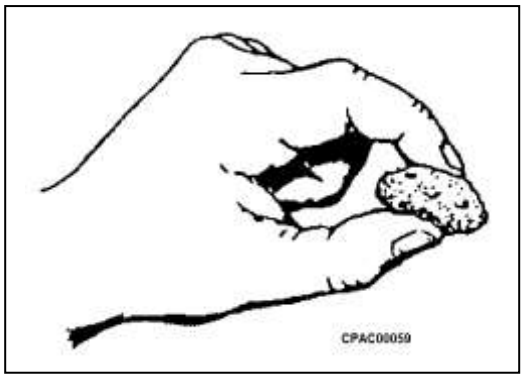
This test method is the most accurate and easiest to perform. It is conducted with an instrument designed to measure density and moisture of soil. The measuring probe uses a radioactive source in combination with Geiger tubes to measure either density or moisture.



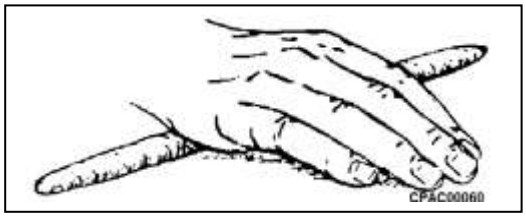
An external detector probe is inserted into the soil to the desired depth. Basically, gamma rays being emitted from the detector probe are absorbed by the soil and water atoms. The denser the soil and the more water present, the more rays are absorbed. Therefore, fewer rays manage to reach the instrument detector to be counted. Thus, the denser the soil, the lower the count rate will be.

VISUAL TESTS

In order to obtain satisfactory compaction results, it is beneficial to recognize the soil type and moisture content. Since it is not always possible to have accurate test data available before starting the job, it is important to have a quick field test. A simple method most often employed in the industry is to pack a soil sample by hand into the shape and size of a golf ball. Place the ball between the index finger and thumb. If the material shatters into fairly uniform fragments, the soil is close to the optimum moisture.



If the material weeps in your hand or does not break but flattens out, the soil is over optimum moisture. When the soil cannot be formed into a ball or is difficult to shape, it is probably under optimum moisture content, and moisture must be added.



To help classify the soil, roll a sample by hand into a thin roll about 1/8 inch in diameter. If there is no problem rolling the material into this shape, the soil is usually clay and extra care must be exercised when attempting to compact. Ideally, the material cannot be rolled into the 1/8 inch diameter, indicating less clay content which is more desirable for compacting.

SOIL DENSITY TESTING

FIELD TEST REPORT

This report is a sample of a typical field test report based upon actual field density testing. The test results are for illustration purposes only. Results may vary depending on operator, carrier and job conditions.

FIELD TEST REPORT

XYZ Soil Testing Laboratories

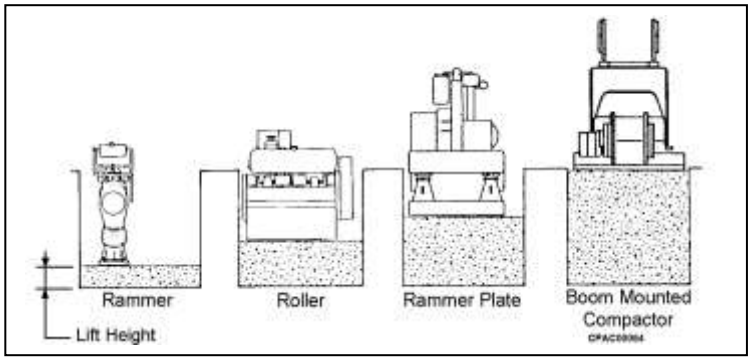
PROJECT		**Compaction Requirements**		**Carrier**	
Trench Backfill Over 8” PVC pipe		Minimum 95% Standard Proctor per ASTM D-698		Caterpillar 416B	
Trench Size		**Aggregate Description**		**Optimum Moisture Content, %**	
7 to 8 ft Deep 24” - 30” wide		Crushed Stone PADOT No. 2 RC		8.2%	
Model No.	Test No.	Lift Depth ft.	Test Elevation in.	Moisture Content %	Percent of Maximum Density
NPK C4C	A	2	Surface	7.6	98
NPK C4C	B	2	-12”	7.6	97
NPK C4C	C	2	Surface	7.6	100
NPK C4C	D	2	-12”	7.6	98
NPK C4C	E	2.5	Surface	7.1	99
NPK C4C	F	2.5	-20”	7.4	96
NPK C4C	G	3	Surface	7.3	99
NPK C4C	H	3	-20”	6.0	97
NPK C4C	I	3	Surface	5.7	96
NPK C4C	J	3	-24”	6.3	97

Field density tests performed in accordance with ASTM D-1556.

CLASSIFICATION OF COMPACTION EQUIPMENT

Compaction equipment can be classified into four machine types, each producing a different type of compactive force:

1. Static
2. Ramming
3. Vibration
4. Combination
   Static, Ramming and Vibration



The differences between ramming and vibratory action are basically the height the machine will jump (*amplitude*) and the number of blows in a given time period (*frequency).*

Static. This term applies to machines that use only their weight on the material for compaction. Static rollers will only compact thin layers of soil.

Ramming. Rammers or Jumping Jacks are generally distinguished by their low frequency (800 blows per minute) and high stroke 1-1/2 to 3-1/2 in. (*38 to 90 mm*). The stroke of a rammer is the maximum height the ramming shoe or plate reaches from ground level while operating.

Rammers are usually hand-held upright machines, which use a spring mechanism. The ramming action breaks down the soil and forces the air out by pushing the soil particles closer together.

The depth of compaction material (or lift) is usually limited to 8 inches *(200 mm)* or less.

Vibration. Vibratory machines are distinguished by high frequency of blows per minute *(2,000 to 6,000)* and lower amplitude.

Each rotation of an eccentric generates a stress wave, which travels into the ground. The purpose of this vibration is to set the soil particles in motion. The soil is broken down and the particles are rearranged. As these particles rearrange themselves, they force out the air trapped between them and fill the voids.

Walk-behind Vibratory Plate and Roller Compactors are capable of lifts up to 20 in. *(500 mm)* deep.

Combination Static, Ramming and Vibration. A Boom Mounted Vibratory Compactor produces a dynamic force into the ground with a series of high frequency rapid impacts. These dynamic forces are influenced by four main parameters: linear load, frequency, amplitude and centrifugal force.

COMPACTION METHODS AND EQUIPMENT SELECTION

In order to achieve the desired level of effective compaction in the selected material, the contractor must select the machine that produces the proper compactive effort.

GRANULAR SOILS
Granular material is not cohesive and the particles require a shaking or vibratory action to move them. Boom mounted compactors are ideal for this application.

CLAY SOILS
Clay is cohesive and the particles stick together, therefore a high impact or impulse force is necessary to ram the soil and force out the air to rearrange the particles. For this soil, a larger model boom mounted compactor works best.

MIXED SOILS
Since soils are usually found as mixtures of clay and granular, machine selection becomes more difficult. Generally, select the machine for the toughest application (the most cohesive soil condition).

COMPACTOR MODEL SIZE vs PERFORMANCE

Lift. The lift height, or the depth of the loose fill being compacted, is an important factor and affects the compactor model selection in two ways:

1. **Performance**
2. **Cost of compaction**

With the properly selected compactor model, soil compacts from the bottom of the lift to the surface. As the compactor imparts energy into the soil, the stress wave travels to the hard surface at the bottom of the lift and returns upward. This action sets the particles in motion and compaction takes place. As the soil becomes compacted, these stress waves have a shorter distance to travel and more force returns to the machine, increasing the vibration at the machine.

If the lift is too deep for the compactor model, a layer of uncompacted soil will be left.

It might seem that the biggest, most powerful model with the greatest compaction effort is the best choice. That's not always the case. In some situations, if the lift is too shallow, it is possible to have too much compaction effort. Unfortunately, there is no formula for determining how much compactive effort is enough - or too much. Different jobs, compactor models, and materials will give different results.

PRODUCTIVITY

It is difficult to accurately predict the productivity of a boom mounted compactor for a particular application. There are many variables to consider - type of material, lift thickness, compaction specification requirement, machine weight, number of passes required and operator skill.

One method to estimate the approximate productivity is to apply the following formula. This formula is a rough assessment of the volume of material a boom mounted compactor can compact in an hour:

METRIC

$$\text{cubic meters/hr} = \frac{A \times L \times C \times E}{T \times P \times M}$$

A = sq. meter, compaction area of baseplate
L = meter, compacted lift depth
C = 3600, conversion factor for time and volume
E = time efficiency (0.75 for a 45 minute hour, 0.83 for 50 minute hour)
T = 30 seconds for average conditions, time to compact a surface area equal to the baseplate area (includes overlap and repositioning)
P = number of passes required
M = 0.7, multiple pass constant (use 1.0 for single pass, shallow trench calculation

Example:
NPK C6C Compactor, using two passes for trench backfill compaction.

A = 0.75 sq. meter **T** = 30 sec
L = 1.2 meter **E** = 0.75

$$\text{cubic meters/hr} = \frac{0.75 \times 1.2 \times 3600 \times 0.75}{30 \times 2 \times 0.7}$$

= 58 cubic meters/hr

U.S. UNITS

$$\text{cubic yards/hr} = \frac{A \times L \times C \times E}{T \times P \times M}$$

A = sq. feet, compaction area of baseplate
L = feet, compacted lift depth
C = 133.2, conversion factor for time and volume
E = time efficiency (0.75 for a 45 minute hour, 0.83 for 50 minute hour)
T = 30 seconds for average conditions, time to compact a surface area equal to the baseplate area (includes overlap and repositioning)
P = number of passes required
M = 0.7 multiple pass constant (use 1.0 for single pass, shallow trench calculation)

Example:
NPK C6C Compactor, using two passes for trench backfill compaction.

A = 8.1 sq. feet **T** = 30 sec
L = 4 feet **E** = 0.75

$$\text{cubic yards/hr} = \frac{8.1 \times 4 \times 133.2 \times 0.75}{30 \times 2 \times 0.7}$$

= 77 cubic yards/hr

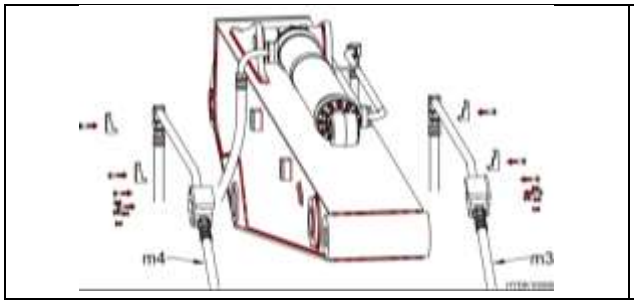
The above formula does not guarantee productivity. Results will vary depending on operator, carrier and job conditions.

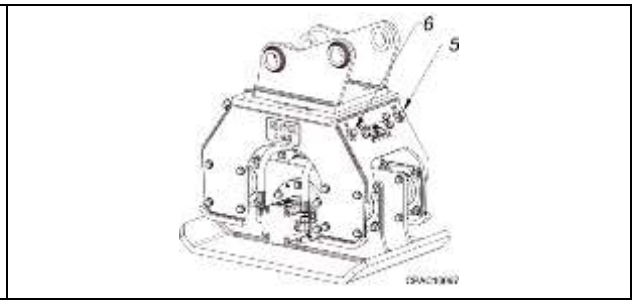
HYDRAULIC INSTALLATION

Hydraulic installation kits are available for virtually all compatible backhoe loaders and excavators from the manufacturer.

Complete parts and instructions for NPK hydraulic installations including valves and/or controls, hoses and fittings, boom and stick tubing and clamps can be provided.

See your NPK dealer for details or call NPK direct at (440) 232-7900.



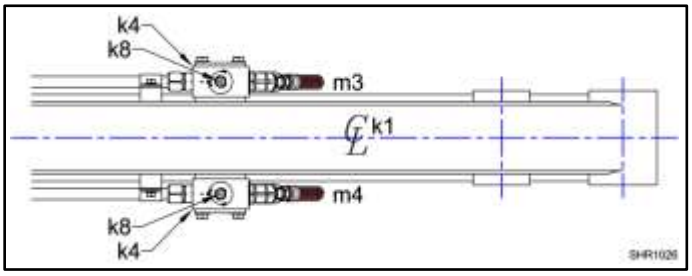


BACKHOE/EXCAVATOR COMPACTOR LINES

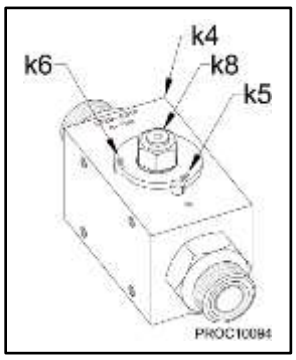
Typically, the pressure line should be arranged on the left side of the boom and routed to the compactor **"IN"** port *(6)* and the return is routed from the compactor **"OUT"** port *(5)* on the right side. Flow to the compactor is controlled from the carrier's auxiliary valve or from an NPK supplied flow valve. Hydraulic oil is generally routed back to the tank through the carrier's oil cooler and filter. **NOTE:** *Do not route return oil through the carrier's auxiliary valve.*

SHUT-OFF VALVES

Most NPK Hydraulic Installation kits use two shut-off valves (k4) on the dipper stick (k1) of the carrier. These valves control the hydraulic oil going to the pressure side (m3) and returning (m4) from the Compactor/Driver. **NOTE:** *Some smaller carriers utilize a check valve on the return side.*



Pressure test ports (k8) are located in the shut-off valves (and check valves). Each shut-off valve has an **"ON"** (k5) and an **"OFF"** (k6) position.



HYDRAULIC INSTALLATION

COMPACTOR CONTROL VALVE

1. **CONTROL SYSTEM USING THE CARRIER AUXILIARY OR SPARE VALVE SECTION.**
   This type of installation uses an existing carrier auxiliary valve to operate the NPK Compactor/Driver. Additional parts, such as mechanical linkage, hydraulic pilot control valves, etc. can be furnished in an NPK HYDRAULIC INSTALLATION KIT.
2. **CONTROL SYSTEM USING THE NPK FLOW VALVE (MULTIVALVE).**
   For carriers not equipped with an auxiliary or spare valve section as part of the control valve bank, the NPK HYDRAULIC INSTALLATION KIT typically includes a solenoid operated, priority valve to operate the NPK Compactor/Driver. *(The NPK Multivalve is specifically designed for the operation of boom mounted attachments.)*

ATTENTION

NOTE: *When operating the NPK Compactor/Driver on a carrier with a return line shut-off valve, be sure the valve is turned to the **"ON"** position to prevent damage to the Compactor/Driver's hydraulic motor.*

RETURN OIL

The return line must be routed correctly and sized large enough to handle the oil flow without creating excessive back pressure. The return oil MUST NOT go through a control valve. It must be connected directly to the carrier's hydraulic reservoir via the oil cooler and return filter *(or an NPK filter, if supplied)*.

To prevent failure of the hydraulic motor shaft seals, motor shaft or motor thrust plates, the return line back pressure must not exceed 150 psi *(10 bar)*. See the **"TROUBLESHOOTING", MEASURING BACK PRESSURE** section of the **INSTRUCTION MANUAL**.

MODEL	MINIMUM LINE SIZE (I.D.)	
	in.	***(mm)***
C2D, C2C, C2	0.50	*(12.70)*
C3D	0.75	*(19.05)*
C4C, C4B, C4A, C4	0.75	*(19.05)*
C6C, C6B, C6	1.00	*(25.40)*
C8C, C8B, C8	1.25	*(31.75)*
C10C, C10	1.25	*(31.75)*
C12C, C12	1.50	*(38.10)*

HYDRAULIC INSTALLATION

PREVENTION OF CONTAMINATION

ATTENTION

1. A compactor/driver is harder on oil than using a bucket, so the oil is apt to deteriorate and breakdown sooner. Neglect of the oil system can not only damage the compactor/driver, but also cause problems in the carrier which could result in damaged components. Care should be taken to check for contamination of the oil and to change it if it is found contaminated. Oil sampling at regular intervals is highly recommended.

❖ When the hydraulic oil shows low viscosity and bubbles, this indicates that the oil is deteriorated. If the oil is dark brown and gives off an offensive odor, it is severely deteriorated. ***Change the oil immediately!***

❖ When the oil is clouded, or the oil filter often becomes clogged, it indicates that the oil is contaminated. ***Change the oil immediately!***

❖ To change the contaminated hydraulic oil, drain the hydraulic system completely and clean components. ***Do not mix new oil with the old!***

2. Do not allow any contamination to mix with the oil. Take special care in preventing contamination from entering the hydraulic system through the hose or tube connection when changing the compactor/driver with the bucket.

3. Low oil level will cause heat build-up, resulting in deterioration of the oil. Also, it may cause cavitation due to air mixing with the oil, leading to a damaged compactor/driver and carrier components. Keep the oil at the proper level at all times.

4. Do not use the compactor/driver at an operating temperature higher than 180°F *(80°C)*. The proper operating oil temperature range is between 120°F *(50°C)* and 180°F *(80°C)*. Since contaminated cooler fins causes reduced efficiency of the cooler, keep the cooler fins clean at all times. Check the hydraulic oil cooling system to be sure it is working effectively. The use of a heat gun is the best way to evaluate if the cooler is working properly.

5. Water in the hydraulic oil will lead to damage of the compactor/driver and carrier. Drain off water and foreign matter from the hydraulic tank at specified intervals. When out of service, the compactor/driver should be stored indoors.

CHANGING THE FILTER ELEMENT AND HYDRAULIC OIL

Change the filter element and hydraulic oil at the intervals described in the operation manual of the backhoe or excavator, when using a hydraulic implement. Another method is to set up an oil sampling schedule and change accordingly.

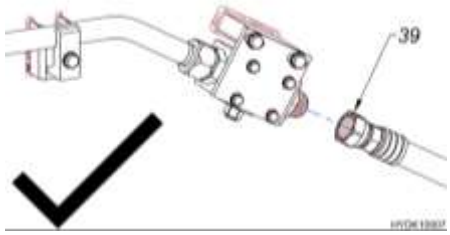
HYDRAULIC INSTALLATION

HYDRAULIC QUICK DISCONNECTS

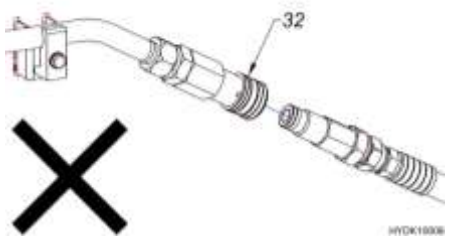
NPK recommends against the use of non-NPK quick disconnects on hydraulic circuits operating NPK Products.

1. Compactor/Driver operation can cause internal pieces of a non-NPK quick disconnect (*32*) to disintegrate. These pieces would migrate into the Compactor/Driver hydraulic motor, causing damage.
2. If quick disconnects are used when the Compactor/Driver is removed from the excavator, the quick disconnects should be capped to keep them clean. If this is not done, contamination in the disconnect will be flushed into the Compactor/Driver when re-connected. This, again, can cause damage.
3. Most quick disconnects create a restriction in the circuit. NPK Compactor/Drivers are back pressure sensitive. Restrictions can cause damage to the hydraulic motor. Also, the pressure required to operate the Compactor/Driver, plus the restriction in the disconnects may push an older, low pressure, carrier machine to the limit of its hydraulic system. This would interfere with proper Compactor/Driver operation. ***However, the NPK approved quick disconnects are properly sized so that the Compactor/Driver operation is not affected.***

APPROVED CONNECTION (39)

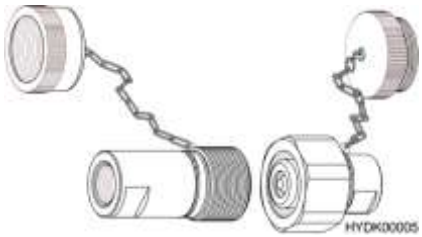


NOT RECOMMENDED CONNECTION
Non-NPK Quick Disconnects (32)

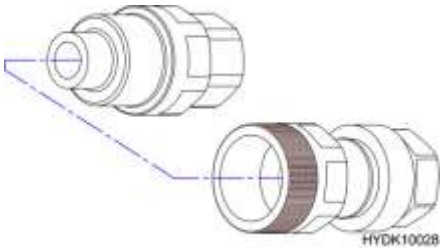


NPK APPROVED CONNECTION QUICK DISCONNECTS
CONTACT YOUR NPK DEALER FOR ADDITIONAL INFORMATION ABOUT NPK QUICK DISCONNECTS

ROFLEX COUPLING



STUCCHI COUPLING



HYDRAULIC INSTALLATION

HYDRAULIC QUICK DISCONNECTS

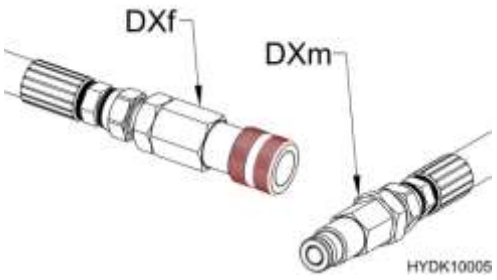
If hydraulic quick disconnects are used with the NPK Compactor/Driver, it is recommended that the following precautions be followed:

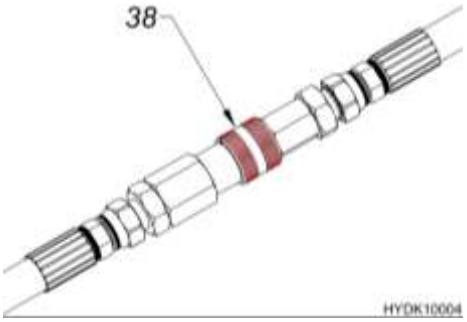
1. Periodic inspection of both male and female ends is recommended to ensure the couplers are in good working condition. Failure to inspect couplers may result in pieces from a damaged or failed coupler to be injected into the hammer or parts of the coupler returned to the machine.

2. Check for dirt, dust, and debris on both the male (DXm) coupler and the female (DXf) before coupling.

3. Be sure that the couplers are completely seated together *(38)*.

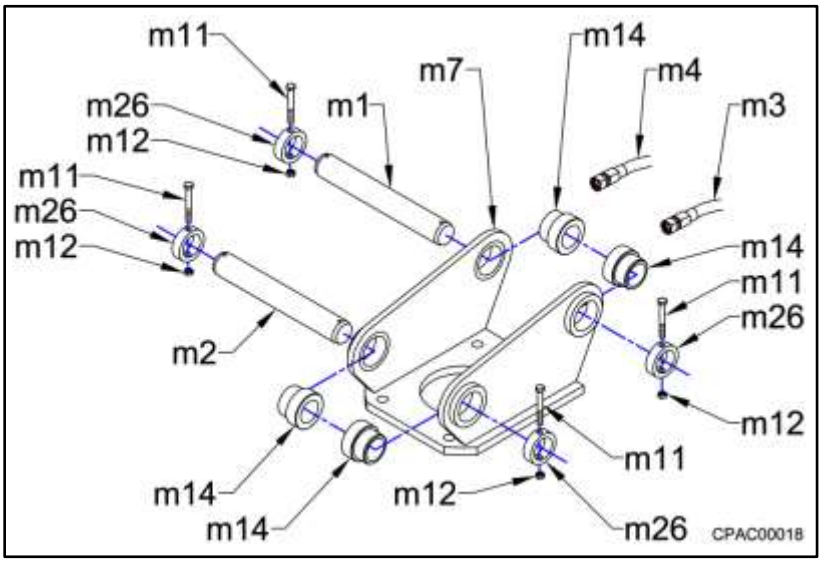
4. When replacing couplers, be sure that couplers are replaced as a set, male and female. Do not use one new end and one used end.





MECHANICAL INSTALLATION

NPK MOUNTING INSTALLATION KITS include the parts required to adapt the NPK Compactor/Driver to the stick or arm of the carrier. Custom adapter brackets and quick attach brackets are available. Shown below is a typical NPK mounting kit. Mounting kits are machine specific. **NOTE:** *NPK mounting kits may not be compatible with other attachments mounted to the carrier.* Contact the NPK Sales Department for additional information.



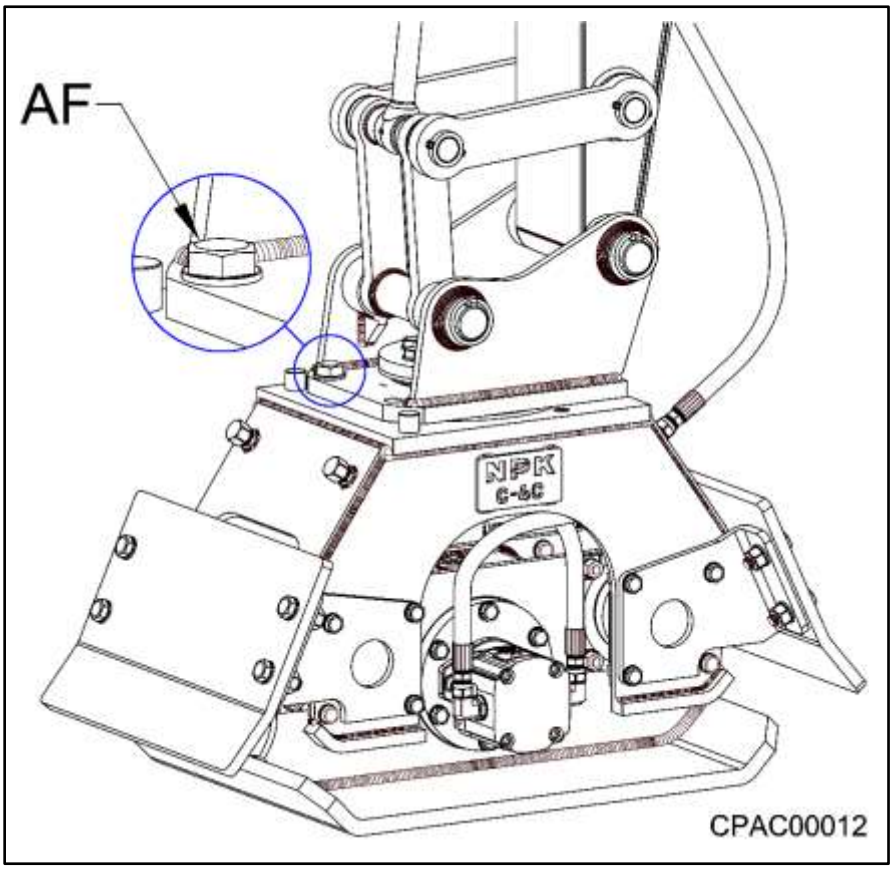
See the FASTENER TORQUE section of the NPK Instruction Manual for top bracket bolt torque.

ITEM	DESCRIPTION
m1	STICK PIN
m2	LINK PIN
m3	HYDRAULIC HOSE ASSEMBLY (*pressure*)
m4	HYDRAULIC HOSE ASSEMBLY (*return*)
m7	TOP BRACKET
m11	HEX HEAD CAP SCREW
m12	HEX NUT
m14	BOOM PIN BUSHING
m26	BOOM PIN COLLAR

ATTENTION

When mounting or removing the Compactor from the carrier, the hydraulic lines must be handled carefully and sealed to prevent contamination from entering the compactor or the carrier hydraulic system.

BACKFILL ATTACHMENT



NOTE: *THE BACKFILL ATTACHMENT CAN BE MOUNTED ON EITHER OR BOTH SIDES.*

NOTE: *BACKFILL BLADE IS ONLY INTENDED TO BE USED FOR MOVING AND THE GRADING OF LOOSE MATERIAL!*

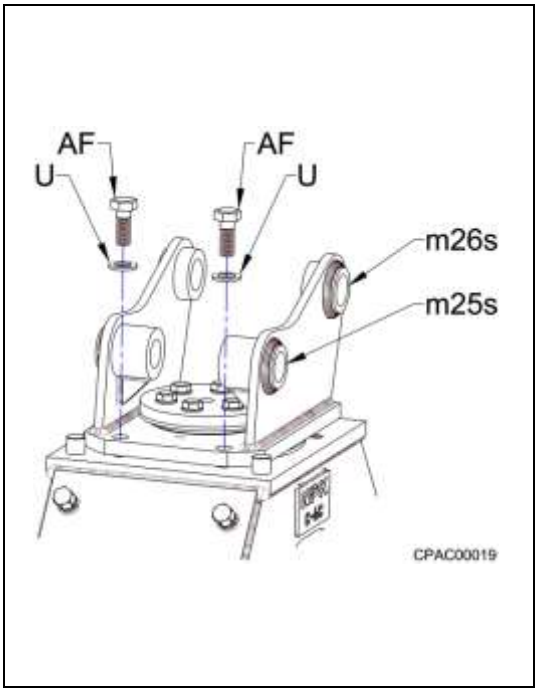
When using a backfill attachment on a swivel style compactor, you ***MUST*** install the two stop bolts (AF) to ensure the compactor will not swivel during use. Failure to do this will result in damage to the compactor.

NOTE: *For backfill blade installation, see **"COMPACTOR/DRIVER INSTRUCTION MANUAL".***

BEFORE OPERATION

DECIDE IF SWIVEL LOCK FEATURE WILL BE USED

The swivel lock bolts (AF) and washers (U) that are found on models equipped with the swivel feature are factory assembled hand tight only. If using the swivel lock feature, these bolts must be loosened then tightened to the specified torque below (also see the **"FASTENER TORQUE"** section of the NPK Instruction Manual) before operating the Compactor/Driver in the "*fixed mode*".



MODEL	TOP BRACKET SWIVEL LOCK		
	BOLT DIA.	TORQUE ft. lbs.	TORQUE *(Nm)*
C2D, C2C, C2	N/A	N/A	*N/A*
C3D	1"	750	*(1020)*
C4C, C4B, C4A, C4	1"	750	*(1020)*
C6C, C6B, C6	1-1/4"	1350	*(1830)*
C8C, C8B, C8	1-1/4"	1350	*(1830)*
C10C	1-1/4"	1350	*(1830)*
C10	1-1/4"	1350	*(1830)*
C12C	1-1/2"	1500	*(2035)*
C12	1-1/4"	1350	*(1830)*

ATTENTION

If these bolts are overtightened, the stick pin (m26s) and link pin (m25s) bores may become misaligned. Loosen these bolts and torque to the proper value. Also, these bolts must be installed on the stick pin side of the bracket or the link pin side of the bracket. **DO NOT** install one at each pin side of the bracket.

ATTENTION

When using a backfill attachment on a swivel style compactor, you **MUST** install the two swivel lock bolts and washers shown above to ensure that the compactor will not swivel during use. Failure to do this will result in damage to the compactor.

BEFORE OPERATION

LUBRICATION

Lubricate Bearings

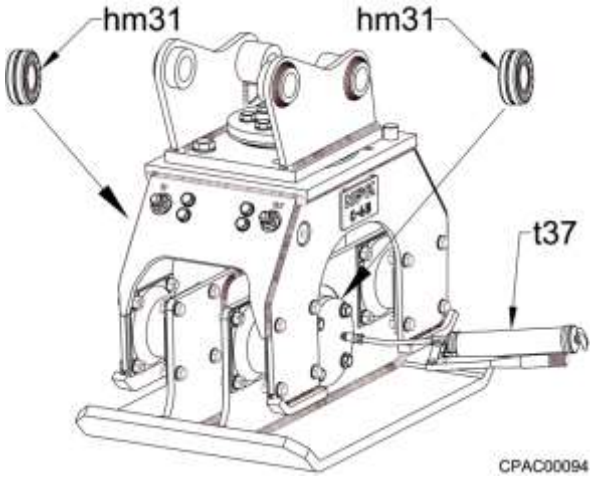
NPK C2D/C2C, C3D, C4C, C6C, C8C, C10C/C10 AND C12C/C12 Compactor/Drivers use oil bath bearings. Check the oil level in the lower frame before start-up, see the **"MAINTENANCE AND INSPECTION"** section of this manual.

NPK C2, C4B/C4A/C4, C6B/C6 AND C8B/C8 Compactor/Driver bearings must be manually greased. Grease before start-up, see the chart in the **"MAINTENANCE AND INSPECTION"** section of this manual.

MAINTENANCE AND INSPECTION

DAILY MAINTENANCE

- **C2C/C2D, C3D, C4C, C6C, C8C, C10C, and C12C** Compactor/Drivers use oil lubrication for the bearings, which may require semi-annual maintenance.
- **C2, C4/C4A/C4B, C6/C6B, and C8/C8B** Compactor/Drivers must be manually greased. Using a grease gun (t37), lubricate each roller bearing (hm31) with the required quantity of grease, per the chart below. If the bearing temperature exceeds 160°F (68°C), the bearings should be greased more often. *Use general purpose bearing grease NLG1 grade 2 with EP additive.*



DAILY BEARING LUBRICATION	
MODEL	**GREASE QUANTITY**
C2	5 SHOTS
C4B, C4A, C4	10 SHOTS
C6B, C6	15 SHOTS
C8B, C8	25 SHOTS

- Periodically check all fasteners and tighten as needed. The hydraulic motor bolts require thread adhesive.
- Periodically check rubber mounts for deterioration or cracking. Wash oil or grease from the rubber surface.
- Oil leakage out of the eccentric housing (lower frame) vent is an indication of hydraulic motor shaft seal failure.
  NOTE: *C2, C4, C4A, C6 and C8 models do not have vents or drain plugs.*
- Inspect eccentric (roller) bearings if they become noisy. Noisy bearings could be an indication of insufficient lubrication.
- Do not operate the Compactor/Driver if the carrier hydraulic reservoir temperature exceeds 180°F (80°C).

LUBRICANT TERMS AND DEFINITIONS

TERM	*DEFINITION*
ADHESIVE	*The ability of grease, gear lubricant or oil to cling to metal.*
ANTI WEAR AGENTS	*Used to help combat metal-to-metal contact, thus reducing wear.*
CAVITATION	*Air pockets in the oil circuit (as at the pump inlet).*
COHESIVE	*The ability of grease, gear lube or oil to cling to itself, thus resisting tearing apart.*
CONSISTENCY	*Consistency of grease is its hardness or firmness. It is determined by the depth in millimeters to which the cone of a penetrometer sinks into a sample under specified conditions. Consistency of grease may be influenced by the type and amount of thickener, viscosity of oil, working and other factors.*
CONTAMINATION	*Foreign material that could damage a part.*
FILM STRENGTH	*Film strength is defined as the tendency of oil molecules to cling together. It is the ability of those molecules to resist separation under pressure between two metals and to hold these metal surfaces apart.*
FORCE	*A push or pull acting upon a body. In a hydraulic cylinder, it is the product of the pressure on the fluid, multiplied by the effective area of the cylinder piston. It is measured in pounds or tons.*
FRICTION	*The resistance to fluid flow in a hydraulic system. (An energy loss in terms of power output.)*
GALLING	*Surface damage on mating, moving metal parts due to friction. A severe form of adhesive wear.*
LUBRICATION	*Use of a substance (grease, oil, etc.) to reduce friction between parts or objects that move against each other.*
NLGI	*A rating given to a grease from the National Lubricating Grease Institute. This rating determines the hardness of the grease and goes from a 000 to a 6 rating. Most greases are NLGI #2 rated.*

LUBRICANT TERMS AND DEFINITIONS

TERM	*DEFINITION*
OILINESS	*Oiliness is measured of the coefficient of friction of a lubricant. Oiliness or lubricity depends on the adhering characteristics of an oil. It is determined by the attraction between the molecules of the oil and the molecules of another material. Of two oils having the same viscosity but different degrees of fluid friction, the one with the lower friction index has the higher degree of oiliness.*
PITTING	*(Gears or Bearings) A type of surface damage occurring under repeated loading of two parts in rolling or sliding contact. A form of surface fatigue.*
PUMP	*A device which converts mechanical force into hydraulic fluid power. Basic design types are gear, vane, and piston units.*
RACE	*A channel in the inner or outer ring of an anti-friction bearing in which the balls or rollers roll.*
RESERVOIR	*A container for keeping a supply of working fluid in a hydraulic system.*
ROLLER BEARING	*An inner or outer race upon which hardened steel rollers operate.*
SPLINE	*Splines are multiple keys in the general form of internal and external gear teeth, used to prevent relative rotation of cylindrically-fitted parts.*
VIBRATION	*A quivering or trembling motion.*
VISCOSITY	*Is the actual SAE weight of the product. Example: motor oils come in 10, 20, 30, 40, 50 and 15/40 SAE weight. The viscosity designation of a lubricant indicates its internal resistance to flow.*

OPERATION

The NPK Vibratory Soil Compactor/Driver derives its power source from the backhoe or excavator on which it is mounted. High efficiency is achieved through a combination of forces developed by the compactor and carrier machine: impulse force, vibration, and downforce. A direct drive hydraulic motor rotates an eccentric mass at high speed to produce ***impulse force and vibration.*** Impulse force is desirable for clay or cohesive soil, while vibration is effective in granular or loose soil material.

Static down pressure from the backhoe or excavator plus the weight of the compactor produces downforce into the material being compacted. As the soil density increases towards the maximum obtainable density, the resistance and developed hydraulic pressure increases. The hydraulic pressure to the compactor is a result of the compactive effort applied to the soil. As the compactor is pressed against the material, the hydraulic pressure to the motor will rise. The greater the downforce, the greater the compactive force developed.

For best results, the rubber mounts, which isolate the lower frame from the upper frame, should be deflected no greater than one-half diameter, see below.

The rubber mounts* (DY) *should not be deflected so far that the upper frame* (EG) *contacts the baseplate* (bp1) *of the lower frame. Do not overstress the rubber mounts by applying heavy down pressure and pulling or pushing (ironing) with the stick.

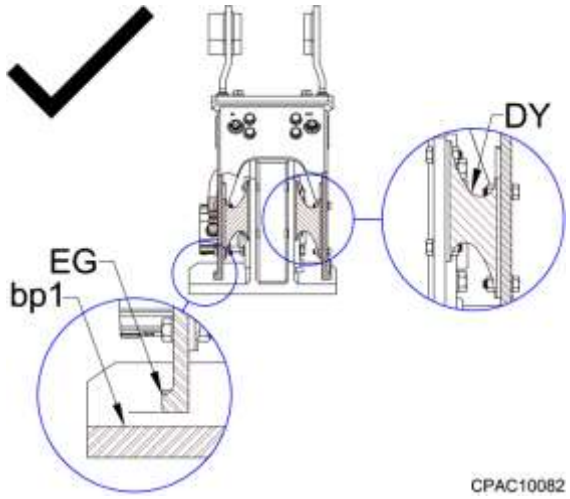


Fig. 1

(Deflection less than one half of the rubber mount diameter.)

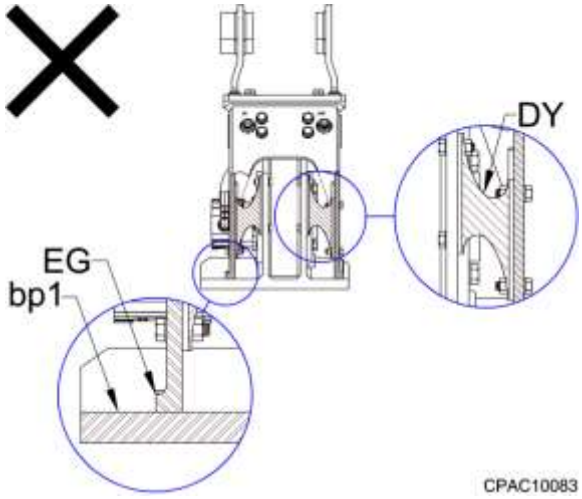


Fig. 2

(Upper frame hitting baseplate.)

OPERATION

SOIL COMPACTION

Trench compaction is usually done in *"lifts"* – the height or thickness of the loose fill. The type and consistency of soil being compacted determines the lift. The more cohesive the soil, the shallower the lift and/or more powerful the compactor must be.

Depending on soil conditions, NPK Compactors are capable of compacting soil to densities in excess of 95% proctor in lifts as shown.

MODEL	LIFT HEIGHT
C2D	Up to 2 ft. (0.6 meter)
C3D	Up to 3 ft. (0.9 meter)
C4C	Up to 4 ft. (1.2 meter)
C6C	Up to 5 ft. (1.5 meter)
C8C	Up to 6 ft. (2.0 meter)
C10C	Up to 7 ft. (2.2 meter)
C12C	Up to 8 ft. (2.5 meter)

OPERATION

SOIL COMPACTION

Ironing vs. “Up” and “Down”

The use of ironing or boom up and down depends upon the job. For compaction of horizontal surfaces, it is usually more effective to reposition the compactor with the boom up and down control. For shallow or slope compaction, ironing may be best. It is also very effective for the final surface pass to obtain a smooth finish.

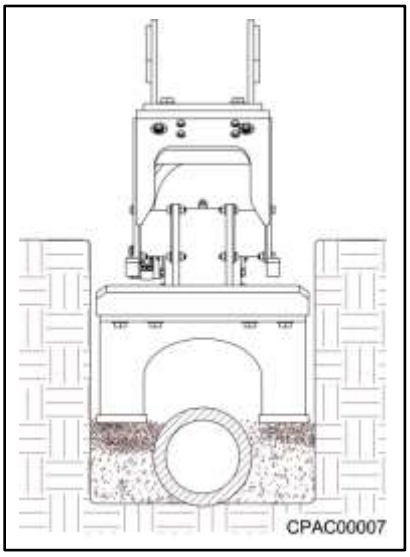
The ironing method should not be used for deep compaction requiring heavy downforce. Ironing with heavy downforce can disturb the already compacted soil and damage the compactor’s rubber mounts.

LEAVE IT RUNNING

It is not necessary to turn the compactor on and off. The compactor can be left running while repositioning. The hydraulic operating pressure is very low without weight applied to the baseplate.

COMPACTION AROUND PIPE

A special attachment foot is sometimes useful when compacting around a large diameter pipe.



ATTENTION

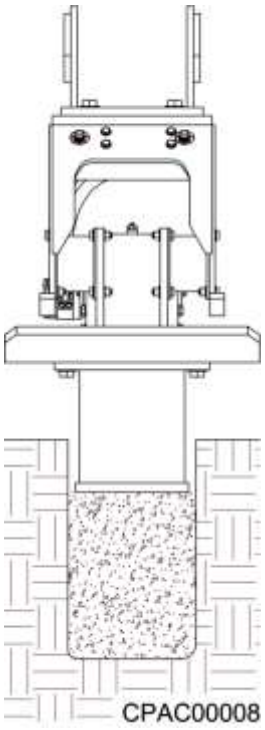
Damage may occur to the pipe if the lift is too shallow or the pipe is inadequately supported underneath. Use caution when operating near weakened structures.

OPERATION

NARROW TRENCH COMPACTION

For operation in narrow trenches, NPK baseplates can be permanently modified to the minimum widths shown.

MODEL	STANDARD WIDTH		MINIMUM WIDTH	
	in.	***(mm)***	**in.**	***(mm)***
C2D	12.0	*(305)*	12.0	*(305)*
C3D	17.0	*(432)*	17.0	*(432)*
C4C	23.0	*(610)*	18.0	*(457)*
C6C	29.0	*(737)*	24.5	*(620)*
C8C	34.0	*(864)*	26.0	*(660)*
C10C	40.0	*(1016)*	29.0	*(735)*
C12C	45.0	*(1143)*	33.0	*(837)*



Another alternative is to adapt a removable narrow extension to the existing compactor baseplate as shown.

OPERATION

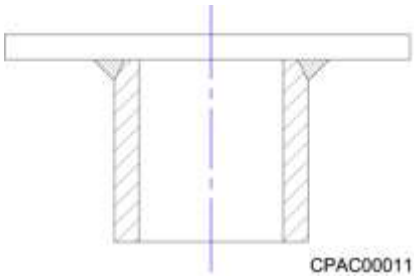
SHEET/PILE DRIVING AND EXTRACTING

Conventional crane mounted pile drivers can be too large, powerful and costly for some applications of sheeting and pile driving. The mobility of the excavator allows operation of the boom mounted driver/excavator in congested city areas, under low bridges, in narrow spaces around bridge piers, etc. The carrier boom provides positioning and the hydraulic system supplies power to the attachment, resulting in a self-contained, very mobile unit. The ability to apply downforce from the excavator boom enables the driver/excavator to out drive larger, cable suspended pile drivers. The low noise level permits driving and extracting in residential areas.

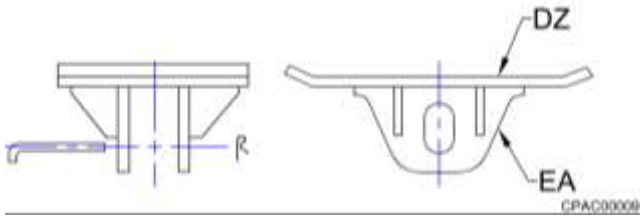
The same vibratory and impulse forces that are effective for soil compaction are also very appropriate for driving of sheeting. In most granular materials, a vertical force down on the sheet or piling is adequate. In more difficult cohesive materials, the baseplate can be positioned on the sheet at an angle or slightly off-center. The offset imparts an impacting or “slapping” motion increasing the driving force.

SHEET/PILE AND POST/PIPE ADAPTERS

The NPK Compactor/Driver can be easily modified for use as a sheet/pile driver and extractor, or pipe/post driver. A simple guide or extracting clevis (EA) can be welded to the baseplate (DZ). Special attachments are available from NPK.



POST/PIPE DRIVER ADAPTER



SHEET/PILE DRIVER AND EXTRACTOR
ADAPTER (DZ) COMPACTOR BASEPLATE

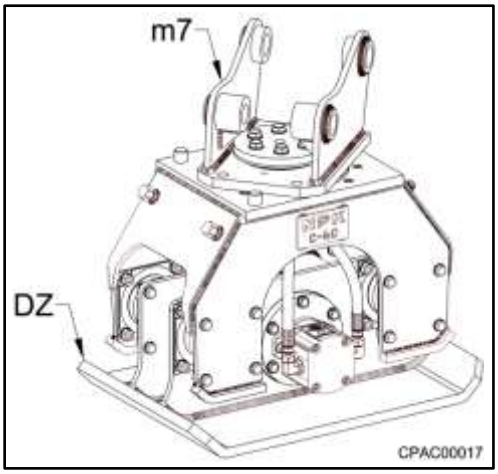
ATTENTION

If using the NPK Compactor attachment for Sheet/Pile or Post/Pipe driving, take caution to add sufficient support for the lower frame.
Contact the NPK Service Department at (440) 232-7900 for details.

OPERATION

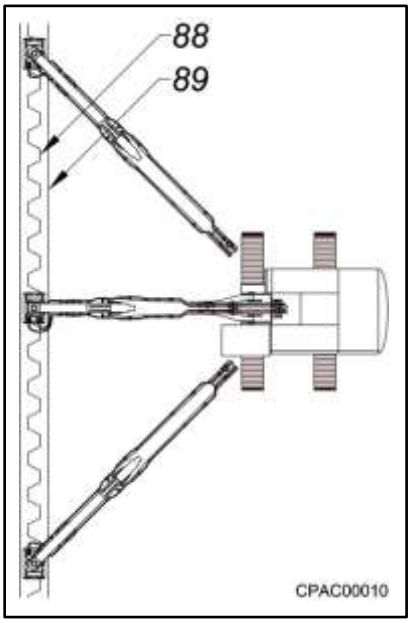
SHEET/PILE DRIVING AND EXTRACTING

SWIVEL FEATURE



A free-turning swivel top (m7) is available as an option on models C4C, C6C, C8C, C10C and C12C NPK Compactor/Drivers. The self-aligning swivel feature minimizes carrier repositioning. The baseplate (DZ) can align to the job from any carrier position, over a wide range of boom positions. The backhoe or excavator can be positioned over, parallel, or perpendicular to the trench if necessary.

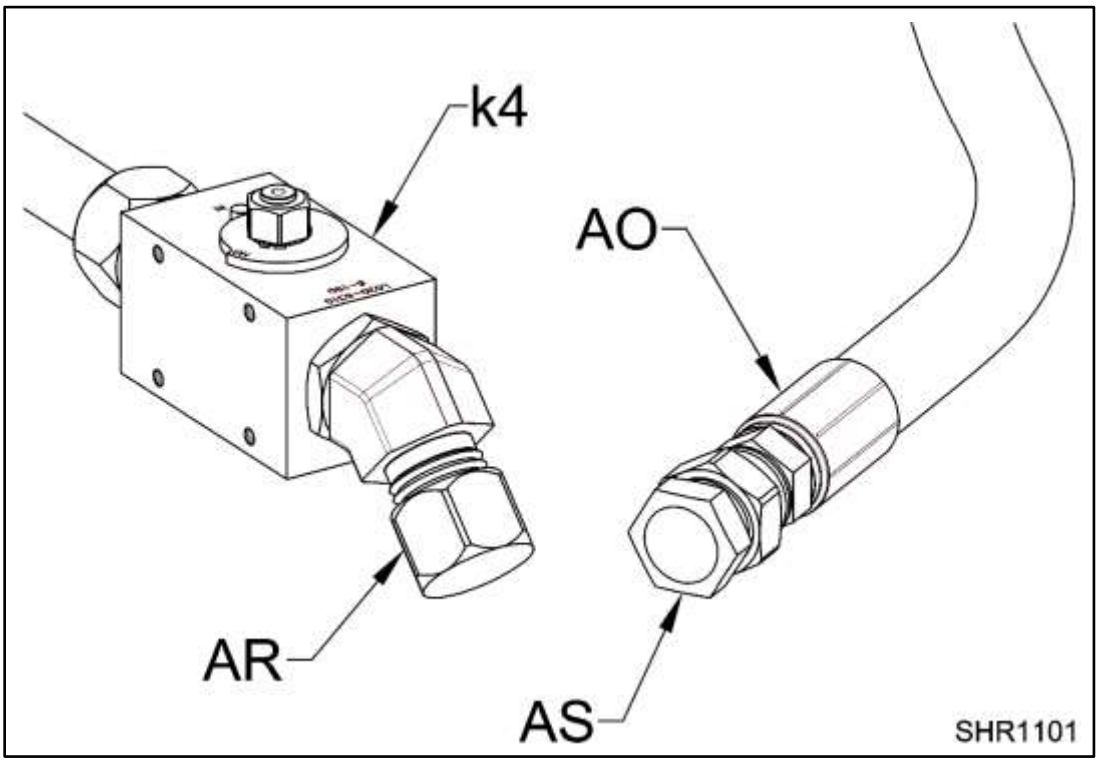
The swivel can be locked in place either parallel or perpendicular to the boom.



88 – Line of Sheeting
89 – Edges of Trench

STORAGE OF THE COMPACTOR/DRIVER

1. Make sure all whip hoses that connect the Compactor/Driver to the carrier are plugged (AS) and all hose (AO) connections are capped (AR). Turn the shut-off valves (k4) to the **"OFF"** position.



2. If the unit is stored outdoors, cover with a waterproof tarp.

WARRANTY REGISTRATION FOR NEW UNITS

Complete and send to NPK after installation or complete on line at www.npkce.com. Online warranty registration can be done by the dealer or the end user.

The registration can be done in any of the following ways.

1. Mailed to:
   NPKCE
   7550 Independence Dr.
   Walton Hills Ohio 44146
2. Faxed: 440-232-6294(U.S.) (+1)(440)232-6294(outside U.S.)
3. Completed online at:
   www.npkce.com

The online registration can be done by the dealer or the end user.

Dealers: In the tool bar click on "DEALER LOGIN".

- Select the NPK Electronic Parts Catalog link.
- Enter your Username and Password, log into the system.
- Select the "Warranty Registration" Tab toward the top of the web page to start (For assistance, please select the "Help" tab located on the top left for a step by step tutorial)
- If the registration is completed online, there is no need to mail or fax the warranty registration.

End users / non NPK dealers

- In the tool bar click on "DEALER LOGIN"
- Select the NPK Electronic Parts Catalog link.
- You do NOT need to fill in username and password.
- Select the "Warranty Registration" Link.
- Enter your information in each field and continue to register your NPK unit(s).
- At any time, you may select the "Help" tab for step by step tutorial.
- If the registration is completed online, there is no need to mail or fax the warranty registration.

WARRANTY STATEMENTS

"Use Genuine NPK Parts" 8/15

NPK WARRANTY
BOOM MOUNTED COMPACTOR/DRIVER

APPLICATION FOR WARRANTY MUST BE MADE WITHIN 30 WORKING DAYS OF FAILURE / REPAIR.

BASE WARRANTY (12 months)

NPK CONSTRUCTION EQUIPMENT, INC. ("NPK") warrants that new Boom Mounted Compactor/Drivers sold by NPK, excluding **MOTOR SEALS** and **RUBBER MOUNTS** which are covered by the PARTS LIMITED WARRANTY, will be free from defects in material or workmanship for a period of twelve (12) months, starting from the date of delivery to the first user.

MAIN COMPONENT EXTENDED WARRANTY (18 months or 1,500 operating hours)

The MAIN COMPONENT EXTENDED WARRANTY covers failure of the MAIN HOUSING, and the ECCENTRIC (excluding BEARINGS), resulting from defects in material or workmanship in those parts under normal use and service for the period starting with the expiration of the BASE WARRANTY and ends eighteen (18) months or 1,500 operating hours, whichever occurs first, from the date of delivery to the first user. NPK MAIN COMPONENT EXTENDED WARRANTY does not cover labor, travel expenses or the replacement or repair of any other part damaged due to MAIN HOUSING or ECCENTRIC failure or repair thereof.

LIMITED WARRANTY (30 days)

The **MOTOR SEALS** and **RUBBER MOUNTS** are covered by the LIMITED WARRANTY to be free from defects in material or workmanship for a period of thirty (30) days, starting from the date of delivery to the first user. NPK LIMITED WARRANTY ***does not*** cover labor or travel expenses.

THIS WARRANTY DOES NOT APPLY TO:

- REPLACEMENT PARTS, HYDRAULIC and MOUNTING INSTALLATION KIT PARTS, and HOSES, which are covered by other warranties.

NPK RESPONSIBILITY

NPK will, at its option, repair or replace with a new or reconditioned part, any warranted part that fails by reason of defective material or workmanship, free of charge delivered at a place of business of an NPK Dealer. Note: Parts replaced under warranty become the property of NPK.

During the twelve (12) month BASE WARRANTY period, NPK will pay the cost of labor at 75% of the posted shop rate that is necessary to install any repaired or replacement part during normal working hours. Overtime rates and travel expenses will not be reimbursed.

USER RESPONSIBILITY

- ***Photos must accompany all warranties submitted to NPK. These photos can be 35mm, polaroid, or digital.***
- The installer, user, operator, repairer, assumes responsibility to read, understand and comply with NPK's written INSTALLATION, OPERATOR and SERVICE INSTRUCTIONS.
- Returning Warranty Registration to NPK at the time of installation.
- All costs associated with transporting the compactor/driver, or equipment to which the compactor/driver is installed, to an authorized NPK Dealer or other authorized location. NPK is not responsible for any expense incurred in field repair.

THESE WARRANTIES DO NOT COVER FAILURES RESULTING FROM:

- Installation, alteration, operation, maintenance, repair or storage which NPK judges improper.
- Not performing DAILY VISUAL INSPECTIONS and/or 20 HOUR INSPECTION AND RETIGHTENING as specified in the NPK MANUALS.
- Return line pressure exceeding 150 psi.
- Inadequate bearing lubrication.
- Operation after discovery of defective or worn parts.
- Unreasonable delay in making a repair after being notified of a potential product problem.

THESE WARRANTIES SPECIFICALLY EXCLUDE:

- Installations not approved by NPK.
- Replacement due to normal wear.
- Repairs by other than an authorized NPK Dealer.
- Use of parts not sold by NPK. **THE USE OF "WILL FIT" PARTS WILL VOID ALL NPK WARRANTIES.**
- Labor charges that are deemed excessive by NPK.
- Parts shipping charges in excess of those which are usual and customary. (Air freight, unless pre-approved, will not be covered.)
- Duties, brokerage fees, and local taxes.

WARRANTY REPAIRS DO NOT EXTEND THE STANDARD WARRANTY PERIOD.

LIMITATIONS AND EXCLUSIONS

Violation of any federal, provincial, state or local laws, ordinances, rules or regulations, or removal or alteration of product serial numbers void NPK's written product warranties. ***Application for warranty must be made within 30 days of failure / repair.***

THIS PRODUCT MUST BE USED IN A SAFE AND LAWFUL MANNER IN COMPLIANCE WITH APPLICABLE OSHA REGULATIONS.

The written product warranties made by NPK set forth NPK's only obligations with respect to any claims of failure, defects or deficiencies in products sold by NPK. **NPK MAKES NO OTHER WARRANTIES OR REPRESENTATIONS WHATSOEVER, EXPRESS OR IMPLIED, OF THE QUALITY, PERFORMANCE, DURABILITY, MATERIALS, WORKMANSHIP, SUITABILITY, CONDITION, DESIGN OR UTILITY OF PRODUCTS SOLD BY NPK, INCLUDING, WITHOUT LIMITATION, IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS, ALL SUCH OTHER WARRANTIES AND REPRESENTATIONS BEING HEREBY EXPRESSLY EXCLUDED. NPK SHALL NOT BE LIABLE FOR SPECIAL, INCIDENTAL OR CONSEQUENTIAL DAMAGES, INCLUDING, WITHOUT LIMITATION, COSTS, LOSSES OR LIABILITIES ON ACCOUNT OF DELAY OR DOWNTIME.**

DISCLAIMER REGARDING OTHER REPRESENTATIONS OR WARRANTIES

No person is authorized to grant any other warranties or to assume any other liability on NPK's behalf unless made or assumed in writing by an officer of NPK. No person is authorized to grant any warranties or to assume any liabilities on the seller's behalf unless made or assumed in writing by the seller.

Internet: www.npkce.com

As used in this warranty the term NPK means NPK CONSTRUCTION EQUIPMENT, INC., WALTON HILLS, OHIO, U.S.A.

WARRANTY STATEMENTS

"Use Genuine NPK Parts" 6/08

NPK WARRANTY REPLACEMENT PARTS

APPLICATION FOR WARRANTY MUST BE MADE WITHIN 30 WORKING DAYS OF FAILURE / REPAIR.

REPLACEMENT PARTS WARRANTY (90 days)

NPK CONSTRUCTION EQUIPMENT, INC. ("NPK") warrants that new Replacement Parts sold by NPK will be free from defects in material or workmanship for a period of ninety (90) days, starting from the date of installation. NPK Replacement Parts Warranty ***does not*** cover labor or travel expenses. Note: Unexpired New Product Warranty has priority over Replacement Parts Warranty.

THIS WARRANTY DOES NOT APPLY TO:

- Wear items such as upper and lower tool bushings, impact ring, retaining bars and pins.
- Tools (covered under separate Tool Warranty).

NPK RESPONSIBILITY

NPK will, at its option, repair or replace with a new or reconditioned part, any warranted part that fails by reason of defective material or workmanship, free of charge delivered at a place of business of an NPK Dealer. Note: Parts replaced under warranty become the property of NPK.

USER RESPONSIBILITY

- ***Photos must accompany all warranties submitted to NPK. These photos can be 35mm, polaroid, or digital.***
- The installer, user, operator, repairer, assumes responsibility to read, understand and comply with NPK's written INSTALLATION, OPERATOR and SERVICE INSTRUCTIONS.
- All labor costs.
- Any expense incurred by field repair.
- Supplying a hydraulic oil sample from the carrier machine upon request by NPK.

THESE WARRANTIES DO NOT COVER FAILURES RESULTING FROM:

- Installation, alteration, operation, maintenance, repair or storage which NPK judges improper.
- Not performing DAILY VISUAL INSPECTIONS and/or RETIGHTENING of fasteners after initial 20 operating hours after repair.
- Exceeding the tool and/or tool bushing wear limit.
- Underwater operation.
- Operation after discovery of defective or worn parts.
- Unreasonable delay in making a repair after being notified of a potential product problem.

THESE WARRANTIES SPECIFICALLY EXCLUDE:

- Installations not approved by NPK.
- Replacement due to normal wear.
- Use of parts not sold by NPK. **THE USE OF "WILL FIT" PARTS WILL VOID ALL NPK WARRANTIES.**
- Parts shipping charges in excess of those which are usual and customary. (Air freight, unless pre-approved, will not be covered.)
- Duties, brokerage fees, and local taxes.

WARRANTY REPAIRS DO NOT EXTEND THE STANDARD WARRANTY PERIOD.

LIMITATIONS AND EXCLUSIONS

Violation of any federal, provincial, state or local laws, ordinances, rules or regulations, or removal or alteration of product serial numbers void NPK's written product warranties. ***Application for warranty must be made within 30 days of failure / repair.***

THIS PRODUCT MUST BE USED IN A SAFE AND LAWFUL MANNER IN COMPLIANCE WITH APPLICABLE OSHA REGULATIONS.

The written product warranties made by NPK set forth NPK's only obligations with respect to any claims of failure, defects or deficiencies in products sold by NPK. **NPK MAKES NO OTHER WARRANTIES OR REPRESENTATIONS WHATSOEVER, EXPRESS OR IMPLIED, OF THE QUALITY, PERFORMANCE, DURABILITY, MATERIALS, WORKMANSHIP, SUITABILITY, CONDITION, DESIGN OR UTILITY OF PRODUCTS SOLD BY NPK, INCLUDING, WITHOUT LIMITATION, IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS, ALL SUCH OTHER WARRANTIES AND REPRESENTATIONS BEING HEREBY EXPRESSLY EXCLUDED. NPK SHALL NOT BE LIABLE FOR SPECIAL, INCIDENTAL OR CONSEQUENTIAL DAMAGES, INCLUDING, WITHOUT LIMITATION, COSTS, LOSSES OR LIABILITIES ON ACCOUNT OF DELAY OR DOWNTIME.**

DISCLAIMER REGARDING OTHER REPRESENTATIONS OR WARRANTIES

No person is authorized to grant any other warranties or to assume any other liability on NPK's behalf unless made or assumed in writing by an officer of NPK. No person is authorized to grant any warranties or to assume any liabilities on the seller's behalf unless made or assumed in writing by the seller.

Internet: www.npkce.com

As used in this warranty the term NPK means NPK CONSTRUCTION EQUIPMENT, INC., WALTON HILLS, OHIO, U.S.A.

NOTES AND RECORDS

NPK COMPACTOR/DRIVER MODEL NUMBER _____

SERIAL NUMBER _____

NPK INSTALLATION KIT NUMBER _____

CARRIER MANUFACTURER	
MODEL NUMBER	
SERIES	
SERIAL NUMBER	

DATE OF INSTALLATION _____

DATE OF 20 HOUR INSPECTION _____ WARRANTY REGISTRATION SENT ❑