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End Effectors and Attachments for Buried Waste Excavation Equipment

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End Effectors and Attachments for Buried Waste Excavation Equipment

Robert H. King

Published September 1993

**Idaho National Engineering Laboratory
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Idaho Falls, Idaho 83415**

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ABSTRACT

The Buried Waste Integrated Demonstration (BWID) supports the applied research, development, demonstration, and evaluation of a suite of advanced technologies that form a comprehensive remediation system for the effective and efficient remediation of buried waste. Their efforts are identified and coordinated in support of the U.S. Department of Energy (DOE), Environmental Restoration and Waste Management (ER&WM) Department's needs and objectives. The present focus of BWID is to support retrieval and ex-situ treatment configuration options. Future activities will explore and support containment, and stabilization efforts in addition to the retrieval/ex situ treatment options.

This report presents a literature search on the state-of-the-art in end effectors and attachments in support of excavation of buried transuranic waste. Included in the report are excavator platforms and a discussion of the various attachments. Also included is a list of vendors and specifications.

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End Effectors and Attachments for Buried Waste Excavation Equipment

1. INTRODUCTION

This report summarizes a literature search on the state-of-the-art for excavation equipment that might be used for buried transuranic waste retrieval. This work is sponsored by the Buried Waste Integrated Demonstration (BWID), whose mission is to provide technologies to the Environmental Restoration Program. One of the areas of focus for these technologies is in the retrieval of buried transuranic waste. This report first gives a brief background into the waste problem in the U.S. Department of Energy (DOE) complex. A discussion follows describing the various types of excavations and excavator platforms including front-end loaders, load haul and design vehicles, revolving shovels, draglines, bulldozers, and skid-steer machines.

This report also describes the current available attachments and end effectors for heavy construction and mining equipment that can be used for digging, grasping, and gripping buried waste. This report does not cover special mobility accessories like gauge wideners or protective devices like guards or other accessories for excavation equipment.

Chapter 3, "Candidate Equipment," summarizes the types of equipment supported by the current available accessories.

Chapter 4, "Attachments and End Effectors," briefly describes and defines each of the attachments and end effectors. It does not give specifications since they vary by manufacturer.

Appendix A, "Attachment and End Effector Vendors," provides example specifications and size ranges. Also, it provides company names, addresses, and phone numbers to facilitate requests for additional information.

2. BACKGROUND

The DOE complex, as well as other Government agencies and private industry, has considerable volumes of buried waste containing hazardous waste such as radiological, organic, inorganic, and heavy metal hazardous substances. The waste was buried by excavating pits and trenches, dumping or stacking the waste objects in the excavations and covering the waste with local soils.

The amount of buried waste located throughout the DOE complex as of 1990 is estimated at approximately 2.1 million m² (Kaal et al. 1993). The DOE facilities where these wastes are predominantly located are: (a) Hanford, (b) Savannah River Site, (c) the Idaho National Engineering Laboratory (INEL), (d) Los Alamos National Laboratory, (e) Oak Ridge National Laboratory (X-10), and (f) Rocky Flats Plant. The wastes at these various sites have been buried or stored in several types of structures. These include: trenches, pits, buildings, storage pads, or other specific structures. Waste disposal activities at DOE sites were conducted in accordance with applicable regulations and laws, and accepted engineering practices at the time.

Approximately half of all DOE buried waste was disposed of before 1970, in accordance with the regulations of that time. During that time, disposal regulations permitted the commingling of various types of waste [i.e., transuranic (TRU), low-level radioactive waste, and hazardous]. As a result, much of the buried waste throughout the DOE complex is presently believed to be contaminated with both hazardous and radioactive materials. DOE buried waste typically includes TRU-contaminated radioactive waste, low-level waste (LLW), hazardous waste per 40 CFR 261, Greater-Than-Class C (GTCC) waste per 10 CFR 61.55, mixed TRU waste, and mixed LLW. Interstitial soils are also believed to be contaminated as a result of these disposal practices, which significantly increases the volume of materials requiring remediation.

Typical buried waste includes construction and demolition materials (lumber, concrete blocks, steel plates, etc.), laboratory equipment (i.e., hooks, desks, tubing, and glassware), process equipment (i.e., heat exchangers, valves, ion exchange resins, and high-efficiency particulate air filters), maintenance equipment (hand tools, cranes, oils and greases, etc.), and decontamination materials (i.e., paper, rags, and plastic bags).

Figure 1 shows that the waste was enclosed in a variety of containers for transport and burial. Typical containers included: steel drums (30, 40, and 55-gal), cardboard cartons, and wooden boxes (up to 105 x 105 in. x 214 in.). Larger individual items were disposed of separately as loose trash. Degradation of the waste containers is believed to have resulted in contamination of the immediate surrounding soil.

Figure 1. Large bulk waste and small waste containers covered with soil at INEL Pit 13 (after Kostelnik, 1993).

Because of current environmental regulations, multiparty agreements, and DOE policy, these sites must be remediated. One option for remediation is to retrieve the waste for ex-situ processing. The BWID mission is to support development and demonstration of technologies that when integrated with commercially-available baseline technologies will form a comprehensive remediation system for the effective and efficient remediation of buried waste disposal throughout the DOE complex (Kostelnik, 1993).

It is likely that the buried waste retrieval equipment will need a suite of attachments since not all of the heterogeneous waste will fit well into conventional excavator buckets. For example, long lengths of wire rope, electrical cables, pipe, or steel supports may be encountered. The retrieval plan may require that the wire rope or cable be pulled from the waste and wrapped on a drum, or it and the other items may be cut into short lengths that will fit into a bucket or other containers.

In addition, retrieval plans may require separation at the dig face. Consequently, the retrieval equipment might have to grip drums, boxes, or caissons, individually. Furthermore, auxiliary activities (i.e., deploying hoses for spraying dust suppressants) may require additional gripping devices. In addition to special attachments and end effectors, very delicate handling of the deteriorated containers might be necessary to prevent spilling, contamination spread, and further waste mixing.

The special accessories must facilitate this delicate handling. For example, high compressive forces might not be allowed by traditional barrel grippers, because they will probably crush deteriorated rusty barrels. It would probably be better to have a grasping mechanism that is flexible enough to conform closely to the shape of the rusty, bent barrel, or a scoop that can fit below the barrel without damaging adjacent containers.

3. CANDIDATE EQUIPMENT

3.1 Front-End Loader and Load, Haul, and Dump Vehicles

Rubber-tired, center-articulated front-end loaders (FELs) and load, haul, and dump (LHD) vehicles are flexible, mobile, and versatile, and could be used to remove overburden or contaminated soil. They can retrieve waste from a position below the dig face, and transport the waste for short distances. The pivot or articulated steering allows the inner and outer wheels to turn in concentric circles. Since FEL and LHD vehicles have a much lower carrying capacity/tare weight ratio than a dump truck, it follows that they are short to medium haul-distance machines.

In addition to a suite of bucket types and sizes, some FEL and LHD vehicles can be fitted with a cradle in place of the bucket. A cradle consists of two forks at the top and a locking tongue at the bottom. In a like manner, the bucket may be changed for a variety of scoops, forks, containers, or platforms and may even be used as personnel carriers.

3.2 Hydraulic Excavators and Backhoes

Figure 2 shows that the hydraulic excavator digging mechanism consists of a boom, stick and dipper. The unit by itself or in conjunction with a truck may be used to dig ditches, trenches, and pits under various terrain conditions. They would be employed to retrieve waste from above the dig face or to remove overburden soil. Some machines, like the Freightliner Small Emplacement Excavator (SEE), employ a front bucket similar to the FEL and a rear-mounted backhoe. From equipment mobility point of view, two types of excavators are distinguished: crawler-mounted and wheel-mounted excavators. Large excavators are commonly mounted on steel crawler tracks. Small- to medium-size excavators are mounted on center-articulated or Ackerman-steered, two-axle wheel carriers. The latter units are particularly handy when the application calls for high mobility but small volume productivity. The stick can be replaced to obtain various reach lengths, and the dipper can be replaced with a variety of tools.

3.3 Revolving Shovels and Draglines

A shovel is made up of the head or the revolving unit, the travel unit, a boom, and the attachments. The revolving unit is built on and around a heavy steel deck. The deck is supported by the swing rollers that rest on the turntable of the travel unit. It carries the engine, transmission, and operating machinery. The travel unit can be a truck, crawlers, or walkers. Shovels and draglines support a wide variety of dipper and bucket sizes. The common attachments include: (a) dippers, (b) dragline buckets, (c) crane attachments like clam shells, (d) magnets, and (e) grapples.

Figure 2. Hydraulic excavator with track gauge widener (courtesy of Weldco-Beales Mfg. Ltd.).

3.4 Bulldozers, Track-Type Loaders, and Tractors

Bulldozers are tractors equipped with a front pusher blade that can be raised or lower by hydraulic or cable control, and is used for digging and pushing. They might be used to push waste or soil to a desired location or to push clean soil into a void created by a retrieval operation. They travel on crawlers or four-wheel-drive rubber-tired tractors. For excavation or heavy pushing, crawler-mounted tractors are preferred. A variety of blades and other material handling attachments, like snow blowers, are available.

Track-type loaders accomplish many of the same tasks as the wheel loader described above, but can operate on terrain that is difficult for wheel loaders.

3.5 Skid-Steer Machines

Skid-steer machines are sometimes called "Bobcats" after the Melroe Company product. They are smaller than the previously described equipment, and can be operated as a backhoe or front-end loader. They are four-wheel, rubber-tired units. As their name implies, they do not use Ackerman or articulated steering, but steer by locking or reversing the wheels on one side while the other side is powered forward.

4. ATTACHMENTS AND END EFFECTORS

The authors mailed a letter requesting information to over 60 companies that manufacture attachments and end effectors. Twenty-four responded. The results from the responses are summarized generically in this section of the report, and the specific vendor products are listed in Appendix A. The product names in Appendix A do not always match the generic names in this section. Appendix A also contains brief specifications for the attachments. Additional specifications and exact costs are available from the vendor, and Appendix A includes addresses, phone numbers, and fax numbers to facilitate further communications.

Asphalt Cutter

The asphalt cutter (Figure 3) is a rotary blade that is pushed downward to score asphalt paving. It aids repair work on roads and utilities installed under roads. The clean score cut reduces asphalt damage during excavation, thereby reducing asphalt replacement costs. Two versions are available, mechanical and hydraulic.

Auger

Figure 4 shows a hydraulic auger that can bore holes in a variety of softer materials. A wide range of revolutions per minute and extensions ensure versatility. It is primarily used for fence posts.

Figure 3. Asphalt cutter (courtesy of CTI).

Figure 4. Auger attached to a backhoe (courtesy of Lowe Manufacturing Co., Inc.).

Blade - Angling

The angling blade can be manually or hydraulically rotated about a vertical axis to move material being pushed to either side of the blade.

Blade - Backfilling

The backfill blade is used to backfill and grade trenches.

Blade - Clearing

The clearing blade has a pointed "V" to knock down trees and brushes. A center-mounted splitter is used for large trees.

Blade - Cushion Dozer

Cushion dozers are designed to push scrapers or track-type tractors. They have a reinforced backup section behind the cutting edge. The height is increased to protect the lift cylinders and allow pushing from a higher position to reduce blade dig. Curvature can be matched to a push block on back of the scraper or tractor. Side plates are extended to aid operators during tandem pushing to catch the stinger when repositioning.

Blade - Dozer

The dozer blade pushes straight ahead of the mobility platform to doze, grade, dig, or clear land.

Blade - Landfill - Double-V

The double-V blade has a wedge shape in the center of the blade that funnels trash to compactor wheels.

Blade - Power Angling and Tilt

The power angling and tilt blade can be hydraulically rotated about a vertical axis to move material being pushed to either side of the blade, and tilted about a horizontal axis.

Blade - Scoop

Scoops are designed to handle large volumes of material. They incorporate tilt, load and carry, lift, and dump features. The operator can dress or cut the side of a pile, push long distances, use the load and carry to fill holes, and feed a hopper with one machine.

Blade - Semi-U

The semi-U blade has a straight cutting edge with small wings to provide better digging/carrying characteristics and more horsepower per foot for harder to dig materials. It combines "cutting ability" and ground penetration with better load retention and less side spill.

Blade - Shear

The shear blade has a low cutting angle to shear material.

Blade - Straight (S)

The straight blade is easier to maneuver and more aggressive in penetrating and obtaining a blade load.

Blade - Universal (U)

The universal blade (Figure 5) moves high volume loads over long distances for land reclamation, stockpiling, charging hoppers, and trapping for loaders. Versions for coal, reclamation, and landfill are available.

Blast-Hole Stemmer

After a blast hole is drilled the cuttings form a mound at the top of the hole. This attachment gathers the mound and pushes it over the hole in one quick scoop, by closing two arms that resemble the sides of a clamp, around the mound.

Figure 5. Sanitary landfill U-blade (courtesy of Weldco-Beales Mfg. Ltd.).

Brush Cutters

Figure 6 shows brush cutters that can be equipped with either rotary cutting disks or flails. They can cut up to 6-in. diameter stems.

Figure 6. Backhoe-mounted brush cutter (courtesy of Weldco-Beales Mfg. Ltd.).

Bucket - Backhoe - Bellhole/Cemetery

This backhoe attachment can dig manholes, underground transformer stations, graves, and other excavations where straight vertical walls and square corners are required.

Bucket - Backhoe - Clamshell

The backhoe clamshell bucket is essentially two buckets attached at a hinge point. It is designed for (a) digging vertical holes, (b) general digging in watery free-flowing material, and (c) grabbing and lifting.

Bucket - Backhoe - Coal/High Capacity

The coal bucket has higher volume than standard buckets because it is designed to handle lower density materials. It loads, carries, and dumps lower density materials more efficiently than standard buckets. It is important to remove this bucket before filling it with heavier materials to avoid exceeding the lifting capacity of the boom.

Bucket - Backhoe - Coral Rock

The coral rock backhoe bucket has short teeth and flared side cutters for tight, abrasive materials.

Bucket - Backhoe - Ditch Cleaning

The ditch cleaning backhoe bucket has a smooth-edged, wide, and shallow design for cleaning ditches, typically applied with a swinger coupler.

Bucket - Backhoe - Drain

The drain backhoe bucket is "V" shaped and has open sides to allow water to drain from the load.

Bucket - Backhoe - Drop Center

The center of the drop-center backhoe bucket drops down for cutting trenches to exact pipe-bedding size to reduce bedding material needs.

Bucket - Backhoe - Ejector

The rear plate of the ejector backhoe bucket moves forward during dumping to eject sticky material.

Bucket - Backhoe - General Purpose

The general purpose backhoe bucket is used in normal conditions and materials.

Bucket - Backhoe - G-Profile

The G-profile backhoe bucket is narrow (7 to 9 in.) for gas or electric pipeline trench excavation.

Bucket - Backhoe - Grab

The grab backhoe bucket has hydraulically actuated claws on the back of the bucket to grab hard onto load materials. The grab can also hold other attachments (i.e., a ripper tooth, asphalt cutter, and grading blade).

Bucket - Backhoe - Heavy Duty

The heavy-duty backhoe bucket provides extra wear material and reinforcement. It is used for digging tight, consolidated materials or in abrasive soils.

Bucket - Backhoe - Jaw

The jaw backhoe bucket opens like a clam to grab objects (i.e., concrete slabs or tree branches) that are too long to fit in the bucket. It is also used as a hydraulic vice to grip tools (e.g., grading and backfill blades, pavement breakers, compactors, drills, asphalt cutters, and rippers).

Bucket - Backhoe - Land Clearing

The land clearing bucket is designed to clear rocks, brush, and other materials without excavating a lot of soil as well. It is shaped so the teeth can skim along the top of the ground surface, and it has large holes for soil to sift through.

Bucket - Backhoe - Muck

The backhoe muck bucket is shallow and narrow and is designed for excavating wet, sticky, cohesive materials.

Bucket - Backhoe - Pavement Removal

The pavement removal backhoe bucket does not have sides so the bottom of the bucket can slip under slabs of pavement or concrete.

Bucket - Backhoe - Pole Erecting

The back of the pole-erecting backhoe bucket is concave and has claws for grabbing poles for installation or removal.

Bucket - Backhoe - Railroad Cribbing

The narrow railroad-cribbing backhoe bucket can dig and clean between railroad ties.

Bucket - Backhoe - Ripper

The ripper backhoe bucket has three to eight teeth (depending on the size of the bucket) on the bottom of the bucket, in addition to the teeth on the bucket cutting edge, for ripping harder materials like rocky and/or frozen ground before excavation. Each tooth is sequentially engaged so

maximum force is applied. The teeth are positioned at a constant radius to produce a relatively flat bottom.

Bucket - Backhoe - Rock

The rock backhoe bucket has extra strength, reinforcement, and wear material for digging in rocky soil. Some buckets have aggressive "V" shapes.

Bucket - Backhoe - Sand

The sand backhoe bucket sides are flared to slope trench sides and reduce cave-in risks in sandy, less cohesive soils. The round bottom shapes the floor of the trench for pipe.

Bucket - Backhoe - Sand Spreading

The sand spreading attachment is designed to load from a pile of loose sand and spread the sand in even lifts. It has a very smooth profile and can have a special device in the bottom to allow for metering.

Bucket - Backhoe - Trenching

The standard trenching backhoe bucket excavates narrow trenches in soft materials like soil.

Bucket - Backhoe - Trapezoidal

Trapezoidal buckets excavate or clean ditches with banked slopes set at a specific angle.

Bucket - Excavator - Coal

Similar to backhoe bucket, but specifically designed for excavators. Designed for excavating and loading shot coal in a stripping application.

Bucket - Excavator - Coral Rock

Similar to backhoe bucket, but specifically designed for excavators. Designed for "peeling" required to dig coral rock. The cutting edge is protected by an increased number of smaller teeth.

Bucket - Excavator - Ditch Cleaning, Grade

Similar to backhoe bucket, but specifically designed for excavators. Designed for ditch maintenance and construction and for grading and slope work.

Bucket - Excavator - Drop Center

Similar to backhoe bucket but specifically designed for excavators. Designed for laying up to three utilities in one trench. The bucket shape digs a lower center trench with an upper trench. Also works well for digging footers.

Bucket - Excavator - General Purpose

Similar to backhoe bucket but specifically designed for excavators. Designed for easy digging dirt and mass excavation projects.

Bucket - Excavator - Heavy Duty

The excavator heavy-duty bucket (Figure 7) is similar to a backhoe bucket, but it is specifically designed for excavators. The heavy-duty bucket is intended for tough clay with rock scattered through the soil.

Bucket - Excavator - Heavy Duty Cast Lip

Similar to backhoe bucket, but specifically designed for excavators. Designed for tough clay lightly mixed with rock.

Bucket - Excavator - Heavy Duty Plate Lip

Similar to backhoe bucket, but specifically designed for excavators. Designed for handling shot rock or demolition work and other high abrasive applications.

Figure 7. Heavy duty rock bucket (courtesy of Weldco-Beales Mfg. Ltd.).

Bucket - Excavator - Heavy Duty Cast Lip

Similar to backhoe bucket, but specifically designed for excavators. Designed for handling poorly shot rock and tough demolition work.

Bucket - Excavator - Pavement Removal

Similar to backhoe bucket, but specifically designed for excavators. Designed to load large precast slabs. The inclined sides of the bucket aid in prying the slabs free.

Bucket - Excavator - Sand

Similar to backhoe bucket, but specifically designed for excavators. Designed for digging sandy soils. Angled sides create a V-shaped trench to reduce side wall collapsing.

Bucket - Excavator - Tilt

The excavator tilt bucket (Figure 8) is similar to a backhoe bucket, but specifically designed for excavators. It is intended to enhance the excavators grading capability for tasks like sloping the sides of trenches.

Bucket - Excavator - Trapezoidal

The excavator trapezoidal bucket (Figure 9) is similar to a backhoe bucket, but specifically designed for excavators. It produces ditches with sloped sides. Long side-cutting edges grade the slopes as it digs.

Bucket - Excavator - V-Line

Similar to backhoe bucket, but specifically designed for excavators. Designed for excavating frozen ground or layered rock, like caliche, frost, coral, and sandstone.

Bucket - Loader - Block Handling

The block handling bucket has a V-edge design to facilitate penetration. The interior profile allows blocks to fit further back in the bucket for increased load and lift capabilities.

Bucket - Loader - Claw (Pincer)

The claw bucket has movable sides. The sides form jaws that clamp loose loads. Its intended loads are garbage, snow, debris, and brush.

Figure 8. Twist-a-bucket (courtesy of Weldco-Beales Mfg. Ltd.).

Figure 9. Trapezoidal bucket (courtesy of Weldco-Beales Mfg. Ltd.).

Bucket - Loader - Cleanup

The cleanup bucket is designed to be used with log/lumber or mill-yard forks. The bucket slips over the tines and is held in place by the fork's clamp. It is intended to be used for general cleanup work at a mill or yard, or for grading when back-blading.

Bucket - Loader - Coal

The coal bucket is designed to provide maximum payload in coal handling. The Wedge floor design increases floor strength to allow higher breakout forces.

Bucket - Loader - Demolition

Figure 10 shows a demolition loader bucket with a strong lid that can grip large objects whose weight and length would cause them to fall out of most buckets when lifted.

Bucket - Loader - Ejector

The ejector loader bucket has a back plate that rolls forward, as the load is dumping, to push sticky material from the bucket.

Bucket - Loader - Fertilizer

The fertilizer loader bucket is designed to handle free flowing materials such as ammonium nitrate, urea or soybeans that have a low angle of repose. To provide more carrying capacity with low angle-of-repose materials, the bucket is deeper than normal.

Figure 10. Demolition bucket (courtesy of Weldeco-Beales Mfg. Ltd.).

Bucket - Loader - General Purpose

The general purpose bucket is designed to handle a wide variety of applications. It will accept bolt-on teeth or a bolt-on cutting edge.

Bucket - Loader - Grading

The grading bucket is designed to be used for backfilling and light grading.

Bucket - Loader - High Dump/Roll Out

The high dump/roll-out bucket is designed for applications that require increased dump clearance and/or reach such as loading from a stockpile to sideboard trucks and hoppers. The bucket pivots close to the cutting edge. It is designed for low density materials like woodchips, snow, fertilizer, coal, grain, and silage.

Bucket - Loader - Landfill

The landfill loader bucket was designed with increased height to carry more refuse than other buckets. The top is made from expanded metal so the increased height doesn't affect visibility. The cutting edge is extended to facilitate carrying of large objects like refrigerators and trees. Multipurpose landfill buckets are also available that allow clamping of large objects and better dozing ability.

Bucket - Loader - Light Material

The light-material loader bucket is designed with light weight and increased volume to carry higher capacities of lower density materials.

Bucket - Loader - Metered

Metered loader buckets control the amount of material discharged. This reduces shock when loading into a hauling unit, hopper, or conveyor. It allows control over truck loads to avoid exceeding highway limits.

Bucket - Loader - Mighty-Bite or Grab-and-Grip

The grab-and-grip or mighty-bite loader bucket has two toothed edges connected by hinged sides. The bucket can be rotated closed about the hinge to grasp bagged silage and other light materials that would normally require a backstop. In the open position, the bucket can push or doze materials.

Bucket - Loader - Multipurpose

The multipurpose bucket (Figure 11) supports several jobs with one attachment, such as loading, stripping topsoil, bulldozing, clamping pipe or large chunks of concrete, and cleaning up debris.

Bucket - Loader - Rock

Rock-loader buckets are made of thick, heat-treated alloys and are designed for high impacts for the difficult conditions of high-density, abrasive rock loading. They have additional wear strips. Some are extra wide to protect tires.

Bucket - Loader - Scrap

Scrap loader buckets don't have sides, which allows longer objects to be lifted. Flexible top clamps hold long, uneven loads on the bucket. They are designed to handle scrap, trash, rubble, and other bulky material.

Bucket - Loader - Side Dump

Side-dump loader buckets can dump forward or to the side. This allows dumping with less maneuvering and for the loader to be efficient in limited-speed areas like between buildings and in underground mines.

Figure 11. Multipurpose bucket (courtesy of Weldco-Beales Mfg. Ltd.).

Bucket - Loader - Skeleton (Rock Tine)

The bottom of the skeleton loader bucket (Figure 12) is made from metal strips spaced to allow sizing of material. Smaller materials fall out of the bucket. Skeleton buckets sift fines before feeding crushers, separate oversize pieces, or load and spread rip rap on earth-fill dams.

Bucket - Loader - Steel Mill Special

The steel mill special bucket is a heavy-duty attachment for steel mill applications.

Bucket - Loader - Woodchip

The woodchip loader bucket is designed to carry large volumes of low-density materials like woodchips, cinders, corn cobs, and dry peat. They have a woven wire top to improve visibility.

Cable Reel

Large cable reels can be attached to equipment for paying-out and taking-up electrical cables and wire ropes. They can include a synchronous level wind.

Car Fork

The car fork is a fork-lift-type attachment that is dimensioned for stacking and handling crushed automobiles.

Figure 12. Rock time bucket (courtesy of Weldco-Beales Mfg. Ltd.).

Clamps - Bucket Top (Thumb)

As shown in Figure 13, loader-bucket top clamps attach directly to the bucket dipper, converting the bucket assembly to a mechanical hand. When the clamp is closed, the material is held into the bucket. When the unit is not needed, it will fold back against the stick of the excavator allowing a full utilization of the bucket. Thumb clamps are available for excavator, backhoe and loader buckets.

Clamps - Bale

When bales are carried on forks, clamps are necessary to eliminate instability during cornering.

Clamp (handler) - Barrel/Drum

Barrel/drum clamps have hydraulic powered arms (shown in Figure 14) that reach around most of the circumference of a barrel to allow lifting and carrying it without damaging or tipping the barrel.

Figure 13. Bucket thumb (courtesy of Mann Corp.).

Figure 14. Barrel handler (courtesy of Weldco-Beales Mfg. Ltd.).

Clamps - Carton

When cartons are carried on forks, clamps are necessary to eliminate instability during cornering.

Clamps - Paper Roll

When paper rolls are carried on forks, clamps are necessary to eliminate instability during cornering.

Compactor - Soil/Sheepsfoot

Soil/sheepsfoot compactors are wheels with lugs that compact soil as they are pushed or pulled and roll over an area. The lugs can also be used to break up and crush ripped surfaces. Figure 15 shows a compactor clamped to a bucket.

Compactor - Vibratory Plate

The vibratory plate compactor is a heavy-duty vibrator mounted above a plate. The plate can be set down on soil for compaction, or placed on top of a post to drive it into the ground. They are capable of reaching into confined spaces such as between a pipe and the side of a trench.

Figure 15. Sheepsfoot compactor (courtesy of Quest Industries, Inc.).

Coupler

Couplers allow several different attachments to be fitted to an excavator. (Figure 16 shows one type.) Some couplers are hydraulically powered so the operator doesn't have to leave the cab. Others require minimal out-of-cab time for tasks such as inserting safety pins and connecting hydraulic hoses.

Couplers for loaders require hitches at the end of the machine boom and hooks (Figure 17) on the attachment. The operator drives the loader to the attachment, sets the hitch under the attachment hooks, racks the boom back, and locks the attachment. Several types of attachment hooks are available. Flat back hooks are designed to be installed on attachments with flat surfaces, such as snow blowers. Profile hooks are designed to be used with general purpose buckets. Blank hooks are designed to adapt to used buckets. Sometimes the correct profile is cut at the time of installation. Tilt couplers allow buckets or forks to be tilted for carrying loads level while traveling across hillsides, changing grade by side tilting the bucket, angle dozing, and stabilizing backhoe digging on hillsides.

Backhoe couplers are available in rigid and swinger types. The coupler mounts on the end of the boom. To attach to a bucket, the coupler hook is inserted in the bucket recess and engages the bucket cross member. Next, the coupler is rotated by extending the backhoe bucket cylinder until the coupler and bucket pin bores align. A hitch pin is manually inserted in the bores and a locking pin is inserted through the hitch pin.

Crane/Material Handling Arm

Hydraulic cranes can be fitted to equipment for hoisting objects like pipe, building materials, and other bulky items. The crane can support many additional attachments. Some cranes/arms are sectional for extension and retraction. Booms can be mounted on the side of a piece of equipment if the front and rear already contain attachments, or if the side is more convenient, for example in pipe laying. A rotating swing boom can be used for moving and swinging loads. It can be used with the hi-rail for rail work.

Cutting Edges

Cutting edges fit on the lower edge of bulldozer blades. Special application cutting edges have extra strength and wear material to handle high impact or high abrasion applications. Multisection cutting edges are not as thick as special application edges and provide wear compensation choices and handling ease. General duty cutting edges provide increased penetration and the most economical service where impact and abrasion are not severe.

Figure 16. Kwik-a-tech coupler (courtesy of Weldeo-Beales Mfg. Ltd.).

Figure 17. Profile and blank coupler hooks (courtesy of Weldco-Beales Mfg. Ltd.).

Delimber

Delimbers remove the limbs from felled trees. Stroke delimbers use a heavy duty hydraulic cylinder. The cylinder extends and pulls the holding grapple and drives the delimbing head in the opposite direction. Tapered knives shear the limbs during the pulling movement. A tree guide tray supports the tree stem during delimbing.

Drawbar Hitch

The drawbar hitch provides an attachment for towing trailers, a compactor, a fuel wagon, or other equipment. Rigid and swinging drawbar hitches are available.

Dredge

A dredging attachment allows the backhoe or excavator to excavate submerged materials or viscous sludge. It has a dual wheel excavator that produces feed to a hopper and pump.

Drill

Masts and drills can be attached for drilling blast holes and other holes.

End Bits

Bulldozer end bits fit on the lower corners of the dozer blade. Extended-wear-life (EWL) end bits provide maximum depth of cut relative to cutting edges. Finish-end-bits match the depth of cut of the cutting edges and protect the blade corner in low-impact, low-abrasion materials. General duty end bits do not extend as far below the support as EWL end bits and are therefore suited to most dozing applications.

Engine Puller

The engine puller has two parts. One is a set of forks that hold an automobile down during an engine extraction activity. The other part is a set of grapple clamps designed to firmly grip automobile engines.

Feller-Buncher (Felling Head)

The feller-buncher, or felling head, shears trees at ground level and grasps them for carrying.

Fifth Wheel

The fifth wheel can be slipped under the front of freight trailers and mobile homes to facilitate maneuvering them.

Fork Carriage - Rotator

The rotator fork carriage allows forks to be attached and rotated 360 degrees for maneuvering in and around objects.

Fork Carriage - Side Shift

The side-shift fork carriage allows forks to be attached and shifted to the side in case a pallet with unaligned material must be lifted.

Fork Carriage - Standard

The standard fork carriage allows general purpose forks to be attached to a variety of excavator equipment.

Fork Carriage - Swinging Tines

The swinging-tine fork carriage allows forks to be attached and adjusted to lift objects having a wide range of widths.

Forks - Core

Core forks are designed to handle veneer blocks at plywood mills.

Forks - Drive-in

Drive-in forks can be mounted on a bucket without releasing the bucket as shown in Figure 18. They attach quickly to the bucket without tools. They allow the loader to handle long materials like pipe, shoring, sheeting, brick, and lumber.

Forks - Loader

Loader forks (Figure 19) give front-end loaders the capability to handle materials on pallets.

Forks - Log/Lumber

Log/lumber forks may have adjustable tines, roll-back guards, swinging or floating tines, and top clamps for handling logs, lumber, and slabs. They can be equipped with single, tandem, and double top clamps.

Figure 18. Drive-in forks (courtesy of CTI).

Figure 19. Loader-mounted forks (courtesy of Guest Industries, Inc.).

Forks - Millyard

Millyard forks have a double top clamp with the double top clamp tines connected with a cross bar.

Fork - Single-Tine Breaker

The single-tine breaker pries loose material at quarry faces and disengages large stone blocks.

Forks - Stinger

A stinger can penetrate, move, and stack bales of hay, salvage autos, etc. It is a long single shaft with a small rectangular frame on the end.

Grader Blade

This blade can be attached to a backhoe for backfilling and light grading. It eliminates the need for additional equipment in many cases.

Grapple - Ball

The ball grapple is used in landscaping to handle balled trees.

Grapple - Cane

The cane grapple has several tines on the bottom and two fork-type clamps above to grip large loads of loose material. It is designed to handle sugar cane.

Grapple - Demolition/Rock

The demolition/rock grapple operates like a clam shell. The lower tines are separated to allow small material to fall through so the grapple can sort and size. It can handle materials like rock, scrap, debris, oversized material such as concrete chunks, and brush. The clamp can compress debris. The closed clamp serves as a dozer blade.

Grapple - High Capacity

The high capacity grapple has two lower tines and a clamp that can grasp large loads of logs. Two types of clamps are used. One is a two-tined clamp that closed between the lower tines, and the other is a baled-type clamp.

Grapple - Loader/Orange Peel)

The loader grapple (Figure 20) is lowered onto the material to grasped from a boom or crane. It has several sharp hinged tines that protrude downward like the fingers of a hand. It usually has three or four tines and an equal number of cylinders. When the grapple is in position, the "hand" closes, gripping the material to be lifted. It is used for loose scrap and other bulky material.

Figure 20. Orange peel grapple (courtesy of Weldeco-Beales Mfg. Ltd.).

Grapple - Log-Sorting Clamp

The log-sorting clamp grapple has two lower tines that will slip under a log. The upper clamp fits between the two tines, so after one log is clamped, another one can be carried at the same time.

Grapple - Pipe/Pole

The pipe/pole grapple has two lower tines that can slip under long objects like pipes or poles. The top clamp contains wedge shaped separators/grippers that facilitate handling pipes or poles singly or in multiple loads.

Grapple - Pulpwood

Used with articulated lift arms, the pulpwood grapple is designed to handle and stack pulpwood.

Grapple - Railcar

The railcar grapple is designed to load and unload pipe and tubing from railroad gondola cars.

Grapple - Rake

The rake grapple is a blade with long teeth at the bottom for raking with a top clamp, as shown in Figure 21.

Grapple - Standard

The standard grapple (Figure 22) is a general purpose grapple.

Hammer/Breaker

This hydraulically or pneumatically-powered hammer (Figure 23) demolishes hard material like concrete and can effectively break rocks where blasting is not efficient.

Log Splitter

Logs must be manually loaded into this attachment for splitting.

Magnet

The magnet can be suspended from a crane or boom to pick up ferrous materials.

Figure 21. Grapple rake (courtesy of Mann Corp.).

Figure 22. Standard grapple (courtesy of Mann Corp.).

Figure 23. Pneumatic hammer (courtesy of CTI).

Mixer

The hydraulically operated concrete or material mixing drum can be attached to several pieces of mobile equipment.

Plow - Root

Root plows remove brush by slicing roots off below the surface.

Pole Erector

The pole erector grasps a pole from a horizontal pile, carries it to a specified location, and turns it vertically for emplacement.

Post Driver

The post-driver tool hydraulically drives fence posts.

Push Plate - Rear

The push plate protects an excavator when it is pushing other equipment or objects.

Push Plate - Moldboard

The moldboard push plate is a tough, heat treated steel plate formed to the blade curve and welded on a dozer blade when the dozer is push loading scrapers.

Pusher/Borer/Puller

The pusher/borer/puller is used to drive utility lines under driveways or roads.

Railcar Coupler

Fixed or sliding couplers are available for moving cars in railyards.

Railroad - Hi-Rail

The hi-rail attachment allows rubber-tired equipment to operate on rails. The driving mechanism consists of a drive hub attached to a railwheel. Using hydraulic pressure, the hub squeezes the rubber tires. Then when the machine is driven, the tires drive the hub which in turn drives the rail wheel.

Rake - Blade

Blade rakes (Figure 24) are used for light duty jobs such as grubbing brush, piling limbs, or raking. The rake fits flush to the blade for support and can be changed quickly from raking to dozing. A pin-type mounting allows the rake to swing away from the blade so piled materials are not dragged back if back blading. A brush rack can be added to increase height and capacity.

Rake - Clamp

Clamp rakes have hydraulic clamps for holding and carrying stumps, trees, poles, and other debris.

Rake - Clearing

The clearing rake clears and controls loose objects at a quarry face or bench.

Rake - Loading/Stacking

The loading/stacking rake has long curved teeth for maximum load capacity. It can scoop under debris and load it at truck height.

Rake - Moldboard

If a small amount of brush or other material is to be raked, a rake can be attached to the moldboard.

Rake - Multiapplication

Multiapplication rakes are designed for heavy-duty clearing including: (a) removal of stumps, (b) boulders or large trees, (c) work in clay, and (d) other heavy soils. The rake has a solid center to protect the radiator and tractor front. Cast teeth, with replaceable tips, are designed for maximum ground penetration and resistance to shock loading. Bush racks can be added to increase height and capacity.

Rake - Rock and Root

Rock and root rakes are used for various medium-duty land clearing jobs such as piling trees, grubbing stumps, spreading riprap, and moving material to windrows. They are especially suited for working in rock. The rake has a solid center to protect the radiator and tractor front. Bush racks can be added to increase height and capacity.

Figure 24. Blade rake (courtesy of Mann Corp.).

Ripper - Multishank Parallelogram

The multishank parallelogram ripper keeps the tip angle constant at any depth. One to three shanks may be used. Ripping depth varies from 20 to 47 in. depending on the equipment.

Ripper - Multishank Radial

One to three shanks can be used in a socket beam design that permits shank depth adjustment.

Ripper - Scarifier

The ripper scarifier has several teeth mounted to a frame that can be raised and lowered hydraulically. It breaks up asphalt, hard clay, thin layered shale and frozen ground.

Ripper - Single-Shank Adjustable Parallelogram

The single-shank adjustable parallelogram ripper tears out tough rock, glacial till, coal, and limestone. Hydraulic tip adjustment varies attach angles, and parallelogram design maintains the tip angle.

Ripper - Single-Shank Impact

The single-shank impact ripper pulls a hydraulic impact trip-hammer through hard materials that otherwise would have to be fragmented by blasting. It is only available for the largest tractors.

Ripper Tooth

This single tooth can be attached to a backhoe boom for ripping. It penetrates and breaks tough materials like frost and caliche so they can be excavated with a bucket.

Rock Guard

The rock guard is installed on the top of bulldozer blades to increase blade capacity while improving visibility and protecting lift cylinders, etc. Recommended for uphill dozing in rocky materials or where large blade loads are typical.

Rolling Chopper

Rolling choppers are a heavy drum or group of drums pulled like a trailer behind an excavator. Blades are welded to the drums to chop up material as it is run over.

Saw - Disc

The disc saw cuts trees. It is mounted above skid shoes that allow the operator to set the head virtually at ground level and help protect the disc. It is usually mounted on a feller buncher mast.

Shear

The shear has a hinged blade and internal hydraulic pressure booster. Very high pressures can be generated to cut rebar and large metal members.

Snow Basket

The snow basket is made of steel straps to reduce weight so it can handle large volumes of snow.

Snow Blower

The snow blower contains a rotating helix to break the snow and a blower and ejection system to bolt it to either side of the machine.

Snow Dozer

The snow dozer is used for pushing snow straight ahead of the equipment.

Snow Plow

The snow plow casts snow in one direction (the one-way plow), in any chosen direction (the reversible plow), or on both sides of the equipment (the V-Plow). The V-Plow is also used for breaking up large drifts. A snow wing can be added that extends to the side of the equipment for clearing shoulders.

Sod Cutter

The sod cutter is used for stripping sod. It has an adjustable cutting depth.

Sweeper

The sweeper (Figure 25) has a rotating cylindrical broom with long bristles. A windrow sweeper windrows material off to the side. The pickup sweeper gathers the material into a hopper for disposal into a truck or other container. Curb brushes can be added to the main brush.

Figure 25. Pickup sweeper (courtesy of Sweepster, Inc.).

Tire Hand

The tire-hand attachment can clamp, remove, handle, and refit large earth moving tires.

Tire Loader

The tire loader is specially designed to feed large loads of discarded tires to a shredder or to load trucks. It has two individually operated top clamps for maximum retention for large loads. A skeleton tine construction allows dirt and water to pass through.

Trash Bin

The trash bin placed near the entrance of a landfill provides a place for small pickup and auto loads of trash, keeping pickups and autos away from congested garbage truck dumping areas. The trash bin is fitted with a quick coupler.

Tree Extractor

The tree extractor grabs a tree and pulls it up, including roots.

Tree Spade/Scoop

The loader-mounted tree spade digs a root ball and lifts and carries the tree. To dig the ball, it pushes several spades into the ground around the tree simultaneously.

Trencher

The hydraulically-powered trencher (Figure 26) can excavate narrow trenches.

Winch

The winch provides a wire rope that can be used for log skidding, steep side hill work, towing, pipeline, and retrieval operations. Fairlead rollers can be added to protect the winch case from cable abrasion during side pulls.

Figure 26. Trencher mounted on a skid-steer excavator (courtesy of Lowe Manufacturing Co., Inc.).

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Appendix A

Attachment and End Effector Vendors

Appendix A

Attachment and End Effector Vendors

Allied
5800 Harper Road
Solon, OH 44139

Phone: (216) 248-2600
Fax: (216) 248-1915

The major attachments include:

- Pedestal Booms
- Buckets: Rotor Sort is a rotating drum with interchangeable sieves that can be attached to wheel loaders or excavators. When open, it works like a bucket. When closed and rotated, fine materials fall through the sieve (1 to 7 yd², 20 to 30 rpm, 89.5 to 145.7-in. width, 31.5 to 67-in. drum diameter).
- Vibratory Plate Compactors (3,000 to 22,000-lb impulse force)
- Hydraulic Hammers (125 to 10,000 ft-lb impact energy)
- Concrete Crushers (124,000 to 465,000-lb crushing force)
- Earth Rock Drill.

American Coupler Systems, Inc.
2151 Radium Road
Kent, OH 44240

Phone: (216) 678-2511
(800) 321-2348
Fax: (216) 678-0859

The major attachments include:

- Backfill Blades (96 to 150-in. width, 37 to 45-in. height, 15 and 25-degree manual angles)
- Extendable Booms (6 to 12-ft length, 6,000 to 7,300-lb capacity)
- Excavator Buckets: Clean Out, Heavy Duty, Severe Duty, Standard Duty (poly lined)
- Grapple Buckets (1 to 4.5 yd²)

- **Loader Buckets:** Coal and Light Material (3 to 7 yd²), Extra Light Material (3 to 12 yd²), General Purpose (1.5 to 4 yd²), Multipurpose (1 to 4 yd²), Side Dump (1 to 3-3/4 yd²), Rock (spade nose and straight edge, 2 to 4 yd²), Snow (2 to 6 yd²)
- **Clamps:** Barrel (1,500 to 3,000-lb capacity, 30 to 55-gal drums)
- **Couplers:** Hydraulic and Manual
- **Forks:** car body (60 to 66-in. width, 60 to 97-in. length), Log/Lumber and Standard Construction Duty (9,000 to 18,000-lb capacity, 12.5 to 60-in. width, 48 to 54-in. length), Material Handling (9 to 102-in. width, 42 to 72-in. length, 3,000 to 25,000-lb capacity), Pipe Grapple (92 to 115-in. width, 54 to 84-in. length, 2 to 36-in. pipe diameter, 10,000 to 22,000-lb capacity), Top Clamp (double and paddle, 82 to 105-in. open, 48 to 54-in. length, 8,000 to 22,000-lb capacity)
- **Rakes:** Loader/Stacking (102 to 140-in. width, 48 to 70-in. height, 8 to 10 teeth)
- **Rippers:** Radial and Parallel.

Rots Inc.
P.O. Box 6
600 Rots Blvd.
Rote, KS 66547-0006

Phone: (913) 456-2224
 Fax: (913) 456-2027

Rots provides attachments for Caterpillar machines (backhoes, hydraulic excavators).

The major attachments include:

- **Asphalt Cutter**
- **Blades:** Angling (hydraulic and power angle tilt, 140-in. width, 44-in. high, 25-degree maximum blade angle), Double-V (15 to 22-yd² rated capacity), Wheel and Track-type Tractor U (coal, reclamation, and landfill, 7 to 94-yd² capacity), Variable Radius Semi-U (6.11 to 10.25 yd² rated capacity), Chip Scoop (20 to 40-yd² rated bucket capacity, 40 to 65-yd² doze capacity), Coal Scoop (15 to 26-yd² rated bucket capacity, 25 to 49-yd² doze capacity)
- **Buckets:** Ditch Cleaning Backhoe (11 to 22 ft²), Ripper Backhoe (3.3 to 6.6 ft²), Heavy Duty Backhoe (3.5 to 18.4 ft²), Tilt (1 to 2.3 yd², 45-degree maximum tilt), Trapezoidal (1 to 5 yd²), Block Handling Loader (6.5 yd²), General Purpose Wheel and Track Loader (1.75 to 4-yd² rated capacity), Rock Loader (standard and extra wide widths, 2 to 15.5-yd² rated capacity), Skeleton Rock Loader (2.5 to 7 yd², 8-in. spacing), Coal Wheel and Track Loader (3 to 28 yd²), Demolition Wheel and Track Loader (1.75 to 5-yd² rated capacity), Landfill Wheel and Track Loader (3.55 to 10.51-yd² rated refuse capacity, 2 to 5.75-yd² rated earth capacity), Woodchip (3.25 to 26 yd² rated capacity), Multipurpose Track

Loader (1.4 to 3.3 yd²), Grab-and-Grip Integrated Tool Carrier (2.85-yd² heaped capacity, 125-in. jaw open width, 87-in. depth, 37-in. height), Excavator (1 to 3.5-yd² rated capacity)

- Clamps - Thumb
- Compactors (6,400 - 22,000-lb force, 4.15 to 9.33-ft² compaction area)
- Couplers: Loader Hitch and Attachment Hooks, Manual and Hydraulic, Rigid Backhoe Coupler, Swinger Backhoe Coupler, Q-Tilt Coupler (± 12 degrees)
- Delimbers (600 to 725-ft/min linear velocity during 40-ft stroke, 24-in. diameter tree capacity)
- Fifth Wheel
- Fork Carriage
- Forks: Pallet (63 to 120-in. width, 48 to 84-in. tine length), Block-Handling Pallet (81-in. width, 73-in. tine length), Single Tine Breaker (matched with loaders breakout force or tipping load, 60-in. tine length), Wheel Loader Cleanup Bucket (3.5 to 3.75-yd² rated), Wheel Loader Core Forks (60-yd², 72-in. tine length), Wheel Loader Logging (56 to 92-in. tine length, 98 to 181-in. maximum opening), Wheel Loader and Integrated Tool Carrier Log/Lumber (48 to 60-in. tine length), Wheel Loader Millyard (53 to 101-in. tine length, 112 to 144-in. maximum opening)
- Grapples (construction—2 tines over 3 tines, medium duty—3 tines over 4 tines, trash—4 tines over 5 tines, 96 to 142-in. maximum opening, 31 to 52-in. jaw width)
- Hooks: Flat and Blank
- Hydraulic Hammers (538 to 8,851 ft-lb impact energy with blunt, chisel, ormoil-point tools)
- Material Handling Arm
- Railcar Coupler
- Rakes: Blade (102 to 121-in. overall width, 40 to 72-in. overall height, 11 to 13-in. tooth spacing), Clearing (81-in. width, 83-in. highth, 328-in. length), Clamp (115 to 123-in. overall width, 51 to 64-in. overall height, 11 to 14-in. tooth spacing), Loader (96 to 120-in. overall width, 48 to 58-in. overall height, 12 to 13 in. tooth spacing), Multiapplication (97 to 157-in. overall width, 56 to 82-in. overall height, 9 to 13-in. tooth spacing), Rock and Root (92 to 156-in. overall width, 32 to 74-in. overall height, 11 to 13-in. tooth spacing)
- Saws: Disc (48 to 55-in. blade diameter, 1,300 to 1,450 rpm, 20 to 22-in. tree diameter), Feller Buncher (108 to 144 in. highth. 58 to 64-in. width, 80 to 84-in. depth)
- Snow Equipment: Hydraulic reversible plow with trip edges for integrated tool carrier (125-in. straight width, 35-degree maximum angle)

- **Sweeper: Rotary Broom and Water Sprinkling System (98-in. working width, 24-in. brush diameter)**
- **Tire loaders (95 to 142-in. width, 59 to 70-in. highth, 70 to 91-in. clamp opening, 12 in. between teeth).**

**Caterpillar Inc.
100 N.E. Adams
Peoria, IL 61629**

Phone: (309) 675-4661

Fax: (309) 675-6951

Working with auxiliary equipment manufacturers such as Balderson, Caterpillar provides attachments with their excavators like the following:

- **Blades**
- **Barrel Clamps**
- **Booms and sticks: Mass Excavator, Special Application, Material Handling, Two-Piece, Long Reach, Hydraulically Adjustable, One-Piece, Logging, Front Shovel, Offset, Medium Stick, Short Stick, Long Stick, Extra-Long Stick, Telescoping Stick**
- **Buckets: Front and Bottom Dump, Extreme Service, Loose Material, Trenching, Extreme Service Trenching, Mass Excavation, Excavation, Rock Ripping, Ejector, Bank Forming, Trapezoidal, Ditch Cleaning, Round Bottom, Chip, Clamshell, Coal, V-Shaped, Jaw/Multipurpose, Trenching Clamshell, Grapple, Sand, Oversized**
- **Versa-Link Couplers**
- **Wheel Undercarriage for hydraulic excavator travel over pavement**
- **Rail Gantry Undercarriage lifts excavator above rails for loading and unloading rail cars, flumes, and barges**
- **Barge Undercarriage for lake and river work**
- **Amphibious Undercarriage for marshy or swampy conditions**
- **Pedestal-Mount Undercarriage for sand and gravel plants, millyards, and other loading and unloading applications.**
- **Conveyor/Stackers**
- **Doweling Drill**
- **Drills**

- Grapples: Two, Three, Four, and Five Tine, Demolition, Grapple/Fork, Grapple/Rake, Log, Grapple/Shear, Sugar Cane, Pipe Clamp, Open-Sided, Tree-Length
- Hopper/Conveyor allows bedding materials to be added to a trench while it is being excavated
- Hydraulic Jaws for breaking and gripping
- Hydraulic Impact Hammer
- Magnets
- Mowers
- Rippers
- Rock Saws
- Saw and Shear-Type Felling Heads
- Sheet/Pile Driver
- Steel Shears
- Vibratory Compactor/Drivers.

Central Fabricators, Inc.
P.O. Box 376
351 Alderson Street
Schofield, WI 54476

Phone: (715) 359-4455
 (800) 782-5454
 Fax: (715) 359-9537

The major attachments include:

- Buckets: Excavator and Front Loader, Ditch Forming, General Purpose, Heavy Duty, Mass Excavation (3 to 5 yd²), Severe Duty
- Bucket Side Cutters (increase cutting lip 4 to 6 in.)
- Coupler
- Ripper: Single Tooth.

CTI
5070 Oakland Street
Denver, CO 80239

Phone: (303) 371-8090
(800) 423-8689
Fax: (303) 371-8097

The major attachments include:

- Loader Bucket Forks (1,200 to 22,000-lb capacity, 35 to 48-in. length, 55 to 72-in. width)
- Asphalt Cutters (19-in. diameter, 5.5-in. cutting depth)
- Pneumatic Hammers (125 to 185 cfm, 950 to 1100 bpm, 500 to 620 ft-lb rated energy).

Danuser Machine Co.
500 East Third Street
Fulton, MO 65251-0421

Phone: (314) 642-2246
Fax: (314) 642-2240

The major attachments include:

- Augers (72-in. maximum auger length, 4 to 36-in. diameter)
- Post Drivers (235-lb force, 52 to 100-in. operating height).

Ellicott Machine Corp.
1600 Bush Street
Baltimore MD 21230

Phone: (301) 837-7900
Fax: (301) 752-3294

The major attachments include:

- Dredges (50 to 120-in. excavator wheel diameter, 13 to 39 rpm, 78 to 850-yd²/hr theoretical production capacity, 4,019 to 48,200-lb cutting force).

General Equipment Co.
1500 East Main Street
Owatonna, MN 55060

Phone: (507) 451-5510
(800) 533-0524

The major attachments include:

- Rotary asphalt cutters (13 to 19-in. diameter, 5 to 5-1/2-in. cutting depth)
- Augers (2018-ft-lb maximum torque, 49 to 113 rpm).

Guest Industries, Inc.
3601 Winsted Road
Torrington, CT 06790

Phone: (203) 482-1118
(800) 243-5390
Fax: (203) 498-6336

The major attachments include:

- Asphalt Cutters: Bucket-Mounted (16 to 18-in. diameter, 5 to 3/4-in. maximum cutting depth)
- Blade: Grading and Backfill (4 to 6-ft length, 14-in. height)
- Compactor: Backhoe or Loader Mounted Sheepsfoot (11 to 24-in. width, 24-in. diameter)
- Forks: Bucket Top-Mounted (2,000 to 25,000-lb lifting capacity, 36 to 72-in. length, 0 to 96-in. adjusting width) Bucket Lip-Mounted (1,000 to 8,000-lb lifting capacity, 36 to 48-in. length), Loader Arm-Mounted (1,000 to 16,000-lb capacity, 36 to 72-in. length, 40 to 83-in. spacing), Bucket Top-Mounted Brick (5,000-lb capacity, 48-in. length, 4 forks), Special Applications (e.g., 45,000-lb capacity), Three-Point Hitch (1,500-lb capacity, 36-in. length, 30-in. spacing)
- Plows: Loader-Mounted Snow (5 to 12-ft width, 18 to 42-in. height, 30-degree angle)
- Pneumatic Hammers: Backhoe-Mounted (125 cfm, 90 psi, 400-ft-lb impact, 100 bpm)
- Rippers: Bucket-Mounted (36 to 69-in. length)
- Sweepers (25 to 32-in. brush diameter, 52 to 104-in. angled width).

LaBounty Manufacturing, Inc.
P.O. Box B State Road 2
Two Harbors, MN 55616

Phone: (218) 834-2123
Fax: (218) 834-3879

La Bounty is a division of Stanley. The major attachments include:

- **Barrel Handler/Crusher (45-in. full open, 40-in. width)**
- **Clamp: Barrel (40-in. full open, 30-in. width)**
- **Concrete Crusher/Pulverizers (18 to 54-in. jaw opening, 13.5 to 55-in. jaw depth)**
- **Couplers**
- **Loader Buckets: Demolition and Scrap**
- **Grapples: General Purpose, Hanging, Heavy Duty, Special Application (1/2 to 12 yd², 4 to 12-ft maximum opening)**
- **Material Densifier (63.5-in. full open, 0.0-in. full close, 30 to 40-in. width)**
- **Shears: Material Breaker, Plate, Rail, Wood (10 to 64-in. opening, 11 to 80-in. throat to tip)**
- **Universal Processors (pulverizer, shear, concrete cracking interchangeable jaws, 20 to 72-in. jaw opening, 18 to 44-in. jaw depth).**

Little Falls Machine, Inc.
305 Third Street S.W.
Little Falls, MN 56345

Phone: (612) 632-9266
(800) 772-PLOW
Fax: (612) 632-3484

The major attachments include:

- **Coupler/Hitch**
- **Snow Equipment: Power Reversible Plow (10 to 12-ft. width, 35 degrees, 43 to 55-in. height), Reversible Plow (manual or hydraulic, 11 to 14-ft. width, 35 degrees, 48-in. height), V-Plow (10 to 12-ft. cutting width, 4.5 to 6-ft nose height, 90-degree cutting edge).**

Lowe Manufacturing Co., Inc.
P.O. Box 275
Readstown, WI 54652

Phone: (608) 629-5101
(800) 356-0180
Fax: (608) 629-5666

The major attachments include:

- **Augers** (10 to 50-gpm hydraulic flow rate, 6 to 48-in. diameter)
- **Trenchers** (8 to 53-gpm hydraulic flow rate, 4 to 12-in. width, 0 to 15-ft depth).

Mann Corporation
11307 Mountain Loop Highway
Granite Falls, WA 98252

Phone: (206) 691-5100
Fax: (206) 691-6134

The major attachments include:

- **Clamp:** Hydraulically operated rotating barrel
- **Rakes:** Blade (10 to 24-in. penetration length, 6 to 10 teeth, 14 to 20 in. between teeth), Loader Bucket (8 to 30-in. penetration length, 5 to 10 teeth, 9 to 16 in. between teeth), Piling Grapple Rake (1 to 5 yd², 6 to 8 teeth, 72 to 129-in. width, 60 to 112-in. open), Rake and Grapple (14 to 15-in. penetration length, 7 to 8 teeth, 15 to 17 in. between teeth)
- **Grapples:** Excavator Thumb (76 to 140-in. open, 30 to 60-in. width), Eagle Thumb/Claw (20 to 52-in. width), Dangling (76 to 140-in. open, 15 to 60-in. width), Crane Grapple Rake (96 to 140-in. open, 36 to 60-in. width)
- **Rakes:** (6 to 9-ft long stick, 1/4 to 7 yd², 2 to 6 teeth, 36 to 72-in. width, may use thumb or swivel grapple).

McMillen Division
States Engineering Corp.
4419 Ardmore Avenue
Fort Wayne, IN 46809-9723

Phone: (219) 747-6195
(800) 348-0964
Fax: (219) 747-9161

The major attachments include:

- Augers (51 to 129 rpm, 470 to 5262-ft-lb torque, 4 to 48-in. diameter)

**Midwestern Manufacturing Company
P.O. Box 3445
Tulsa, OK 74101**

Phone: (918) 446-1587

Fax: (918) 446-6384

The major attachments include:

- Pipe Forks (17,000 to 47,700-lb capacity, 60 to 96-in. tine length)
- Material Handling Arms—Hydraulic sideboom (10,000 to 40,000-lb lifting capacities)
- Hydraulic Winches (15,000 to 100,000-lb line pull)
- Pipe Bending Shoes (4 to 12-in. diameter).

**NPK Construction Equipment Inc.
7550 Independence Drive
Walton Hills, OH 44146**

Phone: (216) 232-7900

Fax: (216) 232-4382

The major attachments include:

- Pedestal Boom/Breaker (16 to 25-ft horizontal reach, 180-degree swing rotation)
- Compactor/Drivers (1,500 to 2,800 psi, 380 to 3,100-lb weight, 3,500 to 38,000-lb impulse force, 2,200 to 2,400 cycles/min, 2.1 to 17-ft² compaction area)
- Concrete Crusher (74 to 180-ton crushing force, 33.5 to 39.5-in. maximum jaw opening, 4,300 to 5,550-lb weight, and 3,550 to 4,000-psi operating pressure)
- Hydraulic Impact Hammer (150 to 20,000 ft-lb impact energy, 150 to 800 blows per minute, 185 to 25,500-lb working weights, 1,600 to 2,700-psi operating pressures, 5 to 2,200 yd² per 8-hr day)
- Steel Shears (12,500 to 18,000-lb weight, 33 to 38-in. jaw opening).

Rammer Inc.
7391 Washington Blvd. Suite 101
Baltimore, MD 21227

Phone: (410) 796-9047
Fax: (410) 796-9313

The major attachments include:

- **Hydraulic Hammers (200 to 15,000-ft-lb impact energy, 300 to 2,200 bpm, 1,378 to 2,393 psi)**
- **Hydraulic Steel Shears (12 to 32-in. jaw opening, 11 to 135-ton crushing force, 3,045 to 4,640 psi, 4 to 17-in. blade length)**
- **Hydraulic Concrete Crushers (21 to 44-in. jaw opening, 36 to 259-ton crushing force, 3,045 to 4,060 psi, 6 to 11-in. blade length).**

Rockland Manufacturing Company
P.O. Box 5
Bedford, PA 15522

Phone: (814) 623-1115
(800) 458-3773
Fax: (814) 623-7214

The major attachments include:

- **Beach Cleaning Machines**
- **Blades: Coal, Clearing, Heavy Duty U, Landfill, Power Angle Tilt, Reclamation U, Semi U, Shear, Tilt, U, Woodchip**
- **Loader Buckets: Cleanup, Coal (2 to 20 yd²), General Purpose (1 to 16 yd²), High Dump (ejector and roll out, 0.75 to 5 yd²), Hot Slag (3 to 14 yd²), Light Material (2 to 25 yd²), Multipurpose (trash handling and general purpose), Rock Tine (2 to 8 yd²), Rock (straight edge and spade nose, 2 to 14 yd²), Slip On, Woodchip (2 to 40 yd²)**
- **Clamps: Bucket and Fork, Center-Mounted, Wide Dual-Cylinder, Two Independent**
- **Compaction Wheels**
- **Concrete Crushers (24 to 54-in. jaw opening)**
- **Couplers: Manual and Hydraulic**
- **Crane Booms: Fixed Length, Manually Extendable, Hydraulically Extendable**

- **Forks:** Car Body, Log, Pallet, Pipe/Pole, Rock
- **Grapples:** Cane, Excavator (90 to 145-in. maximum opening), General Purpose, Heavy Duty, Light Material, Log, Pipe and Pole, Severe Service
- **Plow:** Root
- **Pushblock**
- **Rakes:** Blade, Land Clearing, Loader (79 to 139-in. width, 7 to 9 teeth, 52 to 71 in.), Multiapplication, Severe Service
- **Rolling Chopper:** Single, Tandem, Dual, and Triple (6 to 16-ft cutting width, 3 to 6-ft drum diameter)
- **Rotoveyor** (7-ft wide digging cylinder with teeth that lift material out of the ground to two rotating transfer cylinders that separate soil from debris. A rugged, alloy steel mesh conveyor carries roots and rocks to a storage hopper.)
- **Scoop Dozers:** Coal and Woodchip
- **Shears:** Stump and Trash
- **Snow Basket**
- **Thumbs:** (8 to 18-in. width)
- **Tree Boom.**

**Stanley Hydraulic Tools
Division of Stanley Works
3810 S.E. Nacf Road
Milwaukee, OR 97267-5698**

Phone: (503) 659-5660
Fax: (503) 652-1780

LaBounty, whose attachments were described previously in this appendix, is another division of Stanley. The major attachments provided by the Stanley Works, Stanley Hydraulic Tools Division include:

- **Hydraulic Breakers** (100 to 9,000-ft-lb impact energy, 200 to 1,200 bpm, 1,700 to 2,300 psi)
- **Hydraulic Compactors** (2,500 to 22,000-lb vibratory force, 11.5 × 23 to 32 × 42-in. base plate size, 2,000 to 2,100 frequency, 1,500 to 2,500 psi, 2,500 to 22,000-lb centrifugal force).

Sweepster, Inc.
2800 North Zeeb Road
Dexter, MI 48130

Phone: (313) 996-9116
(800) 521-8766
Fax: (313) 996-9014

The major attachments include:

- Sweepers: Tow Behind Pick-Up (60 to 84-in. sweeping path, 36-in. diameter main brush, 2-yd² hopper capacity, 14,634), Front Pick-Up (48 to 84-in. sweeping path, 24 to 32-in. diameter main brush, 12-ft² to 2-yd² hopper capacity), Tow Behind Windrow (84-in. sweeping path, 32-in. diameter main brush).

Ware Machine Works
East Main Street
P.O. Box 390
Ware, MA 01082

Phone: (413) 967-6291
Fax: (413) 967-7008

The major attachments include:

- Heavy duty pedestal booms with 12 to 27-ft horizontal reach
- Quick Detachable Backhoes for a variety of mobility platforms
- Backhoe Buckets (3.4 to 5.4 ft²)

Weldco-Beales
2328 Roosevelt Ave
P.O. Box 8
Enumclaw, Washington 98022-0008

Phone: (800) 547-6357
Fax: (206) 825-4009

The major attachments include:

- Blades: Angle (manual or hydraulic), Backfill (12 to 20-in. height, 72 to 108-in. width), Chip (150 to 240-in. width, 58 to 90-in. height, 11.5 to 45 yd²), Coal, Landfill (150 to 240-in. width, 58 to 90-in. height, 11.5 to 45 yd²), Snow, Straight, Heavy Duty U (132 to

188-in. width, 46 to 72-in. height, 6.5 to 23 yd²), Light Material U (150 to 240-in. width, 50 to 90-in. height, 8.7 to 42 yd²)

- **Excavator Buckets:** Bottom Dump (3 to 7 yd²), Cleanup (1 to 5 yd²), Clamshell (0.5 to 1.5 yd²), Coal (2.5 to 6 yd²), Coral, Dropped Center, Frost, Heavy Duty and Rock (3/8 to 6.5 yd²), Trapezoidal (1 to 3-1/4 yd²), Twist-A-Bucket (3/8 to 6-1/2 yd², 12 to 84-in. width)
- **Loader Buckets:** Chip (3.5 to 45 yd²), Demolition (5/8 to 5 yd²), General Purpose (0.75 to 12 yd²), Heavy Material (4.5 to 8 yd²), Multipurpose (0.75 to 5 yd²), Rock (straight edge and spade nose, 2 to 13.5 yd²), Rock Tine (1.5 to 8 yd²), Side Dump (1 to 6 yd²), Slip-on (2 to 10 yd²)
- **Casing Hammer**
- **Clamps:** Barrel (28 to 30-in. open, 45-gal drums, 3,000-lb capacity)
- **Compactor/Drivers** (24 × 30 to 34 × 40-in. baseplate dimensions, 100 to 2,000-psi operating pressure)
- **Couplers**
- **Ditch and Cleanup Buckets**
- **Brush Cutters** (36 to 60-in. cutter diameter, 1,200 to 1,800 rpm, 650 to 1,800-lb weight)
- **Forks:** Brick, Log, Lumber, Pallet, Pallet With Top Clamp, Peeler Blocks, Pipe, Pole, Pulpwood
- **Grapples:** Butt 'N' Top, Log Loading (32 to 72-in. open), Orange Peel and Rock (single cylinder and 3 tines, 4 cylinder and 4 tines, 58 to 115-in. open), Power (27 to 52-in. open), Pulpwood (8 and 16 ft, 90 to 172-in. open, 5/8 to 2-1/4 cord capacity), Scrap, Sorting, Tree Length Rotating Butt (54 to 82-in. open)
- **Twist-a-bucket adjusters**
- **Rakes:** Brush (96 to 140-in. open jaw dimension, 36 to 54-in. width), Grapple (72 to 128-in. width, 12 to 18-in. tooth penetration, 72 to 97-in. open), Land Clearing (88 to 167-in. width, 12 to 23-in. tooth penetration, 41 to 77-in. height), Mold Board (72 to 120-in. width, 14 to 20-in. tooth penetration), Power Cant (36 to 44-in. open), Power Rotating (27 to 52-in. open, 14 to 15-in. width), Power Clearing (45 to 58-in. open, 36 to 42-in. width), Tooth (10 to 20-in. digging depth)
- **Rippers:** Parallelogram (1 to 3 shank brackets, 66 to 100-in. width, 20 to 60-in. penetration), Tooth (18 to 36-in. penetration)
- **Backhoe Ripper Box**
- **Stump Splitters** (90 to 108-in. length)

- Thumb
- Winches, Arches, and Fairleads.

Werk-Brau Co., Inc.
P.O. Box 545
Findlay, OH 45839

Phone: (419) 422-2912
 (800) 537-9561
 Fax: (419) 422-7207

The major attachments include:

- Backhoe Blades: Grading (48 to 72-in. width)
- Backhoe Buckets: Cemetery (48 to 72-in. width), Coral Rock (2.5 to 7.2 ft²), Ditch Cleaning and Grade (7.8 to 21.6 ft²), Ford Style, Heavy Duty (12 to 36-in. width), Pavement Removal (12 to 48-in. width), Railroad Cribbing, Snow (2 to 10 yd²), Standard Duty (12 to 36-in. width), Universal (standard, heavy duty, extra heavy duty, and severe duty rock, 12 to 36-in. width, standard and high capacity), E-Z Tilt (45 degrees), V-Ditch (24 to 60-in. top width), V-Line (3.4 to 9 ft²)
- Couplers: Backhoe and Excavator (hydraulic and mechanical)
- Excavator Buckets: Coal (1 to 6 yd²), Coral Rock (1/2 to 2 yd²), Ditch Cleaning and Grade (7.8 to 21.6 ft²), Drop Center, General Purpose (3/8 to 4 yd²), Heavy Duty (3/8 to 4 yd²), Heavy Duty Cast Lip (3/8 to 4 yd²), Heavy Duty Plate Lip (3/8 to 4 yd²), Extra Heavy Duty Cast Lip (3/8 to 4 yd²), Pavement Removal, Sand (1 to 6 yd²), E-Z Tilt (45 degrees), Trapezoidal (3/4 to 1-3/4 yd²), V-Line Strata Rock-Frost (1/4 to 3 yd²)
- Grapples: Backhoe and Excavator (Demolition, General Purpose and Stump Removal), Skid-Steer Scrap Grapple
- Loader Buckets: General Purpose (7/8 to 6.5 yd²), Heavy Duty (3/4 to 5.5 yd²), Light Material (2 to 9 yd²), Multipurpose Quadra Bucket, and Skid-Steer Quad, Skid-Steer Utility (3 to 33 ft²), Snow (2 to 10 yd²)
- Rakes: Backhoe and Excavator
- Rippers: Backhoe and Excavator (single point tooth), Thumbs: Backhoe and Excavator E-Z Grip Material Handler
- Wheel Compactors: Backhoe and Excavator.

**DATE
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5/27/94

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