2012

*Chip*BLASTER

High Pressure/High Volume Coolant Systems

Product Explanation Manual

ChipBLASTER Inc.
January 2012

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Company History

ChipBLASTER has been in the business of making high pressure coolant delivery systems for many. Over that time we have developed and incorporated many unique features into our product line. Many of these features provide benefits that are still unmatched in the metal cutting industry.

We are an ISO 9001 certified company that takes pride in the quality and services we provide our global customer base. Having gained our ISO 14001 certification, we also realize the importance of being environmentally friendly and continue to make products that increase machine tool efficiency, provide cleaner working conditions, and longer lasting cutting fluids.

When applying a "new" technology, it is a common misconception that trial and error can provide the quickest results for a successful application. However, we have discovered that by utilizing accepted laws of physics, chemistry, and mathematics, that we can ensure that you get the optimal results with the least time spent designing the process.

ChipBLASTER employs a full time engineering and applications staff dedicated to providing the best possible solutions to your metal cutting and filtration issues. Through our extensive testing and consortium of partner companies, we have gained the technical expertise to provide you:

- Longer Tool Life
- Longer Coolant Life
- Superior Chip Control
- More Part Throughput
- Faster Cutting Speeds

These advantages commonly show a significant reduction in the payback period on new machine tool equipment, tooling, services, and filtration products.

We invite you to contact us and have one of our experienced, friendly staff to review your application and process today. Call us at (+1) 814-724-6278.

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Product Overview

Product Definition:

ChipBLASTER distinguishes coolant delivery systems as either fixed rate volume or variable volume systems. Systems are defined based upon volume of coolant flow, available pressure, voltage and hertz, coolant type, tank capacity, and type of filtration. Numerous additional options are available to make a ChipBLASTER unit fit various individual customer needs.

In order to determine which ChipBLASTER system best meets the customer's needs, it is important to identify the machine tool to which the unit will be connected, the power rating of the spindle, and the number of outlets required. It is also important to understand the machining requirements of the application.

ChipBLASTER provides support to the machine tool OEM upon request to assist in choosing the best system to meet the customer's needs.

ChipBLASTER Advantages:

Fitting a machine tool with a ChipBLASTER system offers many advantages over competitor systems. The technology used in ChipBLASTER systems offers many selling arguments in comparison with the competition.

Filtration: ChipBLASTER filtration is specified to a standard degree of purity of 5µm for water based systems and 10µm for oil based systems. Our media-free filtration is specified to a standard degree of purity of 2µm. Competitor systems offer standard filtration in the range of only 25-50µm which decreases the purity of the coolant and therefore also the coolant life-time.

Coolant: Because our variable volume systems pump and filter only the volume of coolant required to ensure sufficient cooling, coolant life as well as the durability of the ChipBLASTER system can be greatly extended in comparison with competitor systems. This same technology also eliminates unwanted sources of friction (and heat) from the coolant delivery system.

Tool Life: By effectively preventing the formation of a super-heated vapor barrier around the point of cut, our technology ensures that both heat and chips are removed from the chip-tool interface. This allows for normal tool wear patterns and greatly extended tool life. Our high pressure systems are available in standard nomenclature for a pressure range of 70-200 bar. Higher pressures are available upon customer request.

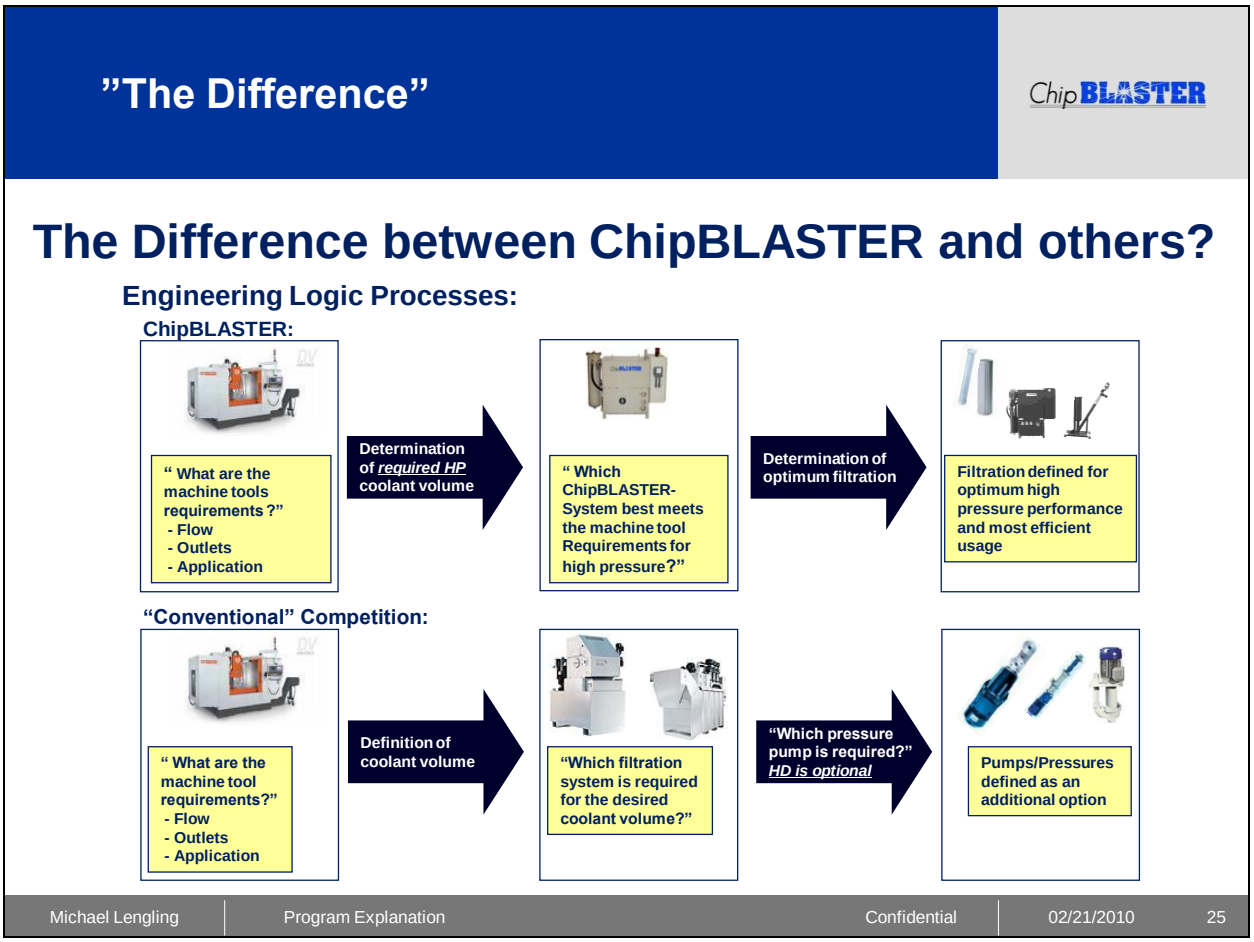
Productivity: For the reasons stated above, our systems allow for higher productivity while at the same time ensuring no reduction in tool life. In many cases, both productivity increases and extended tool life are possible.

Modularity: Modular design of coolant tanks and high-pressure modules allows for numerous variations in unit construction without extended lead time for reengineering and without development costs. ChipBLASTER offers a large range of additional options meeting these modularity requirements.

Technology: Our systems utilize our own patented technology and experience in R&D projects to make innovative solutions available to our customers at an attractive price. Many tooling manufacturers use our patented technology in their own tooling designs.

Comparison with Competitor Systems:

A direct comparison of ChipBLASTER systems to "conventional" competitors is difficult due to our unique ChipBLASTER approach to coolant delivery.



Competitors:
The system definition is based upon coolant filtration specification. *High pressure pumps are offered as an option* to the filtration system.

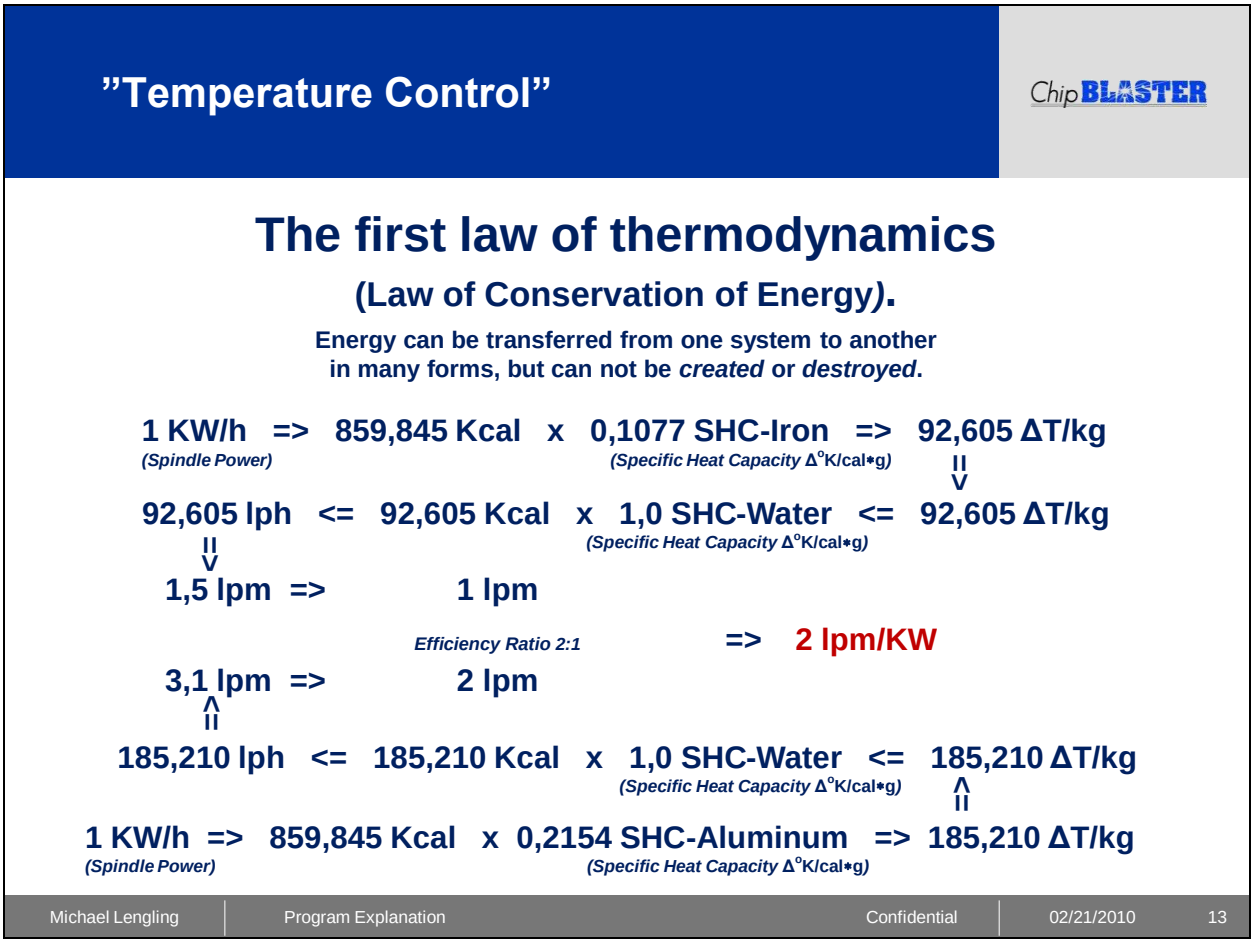
ChipBLASTER:
The system definition is based upon *the coolant flow required to ensure optimum high-pressure performance*. The filtration system is designed to ensure both the *required* degree of purity and optimum high pressure system performance.

In summary, ChipBLASTER designs and manufactures high pressure coolant systems, the competition offers automation and filtration with a limited flow or pressure option.

"How to choose the right unit"

Technical Specifications to Use when Sizing a System:

Based on presented information, we have concluded that 2 l/min. per KW of the machine tool spindle power (for milling or turning operations) can be used as a rule of thumb to size your ChipBLASTER.



Example:
A machine tool with a 15 KW spindle motor would need 30 l/min of fluid
(15 KW x 2 l/min per KW = 30 l/min)

This means the ChipBLASTER D30-70 (30 l/min @ 70 bar) or JV40 (8 to 40 l/min @ 70 bar) would be the right ChipBLASTER unit for this application.

"Rule of Thumb" 2 l/min per Machine Tool KW spindle power

Another way to size the system – especially for drilling operation - is by determining the volume required by drill diameter. A talk with the customer about the drill range and largest drill used is helpful to determine the proper size of the ChipBLASTER. In this case we developed the "Rule of Thumb" of 1.5 l/min per 1mm diameter of drill.

Example:
The customer is using drills up to 25mm in diameter (1.5 l/min x 25mm = 38 l/min).

This means the ChipBLASTER JV40 (8 to 40 l/min @ 70 bar) would be the right ChipBLASTER model for the application.

"Rule of Thumb" 1.5 l/min per 1mm Diameter of Drill

The third "shortcut" to size a system is by determining the volume required by the number of "teeth" the customers milling cutter has. It is important to pay specific attention to the largest cutter with the most cutting teeth. In this case we developed the "Rule of Thumb" of 7.5 liters per cutter insert.

Example:
The customer is using a face mill that is 50mm in diameter and has 6 cutting inserts.
(7.5 l/min x 6 cutting inserts = 45 l/min)

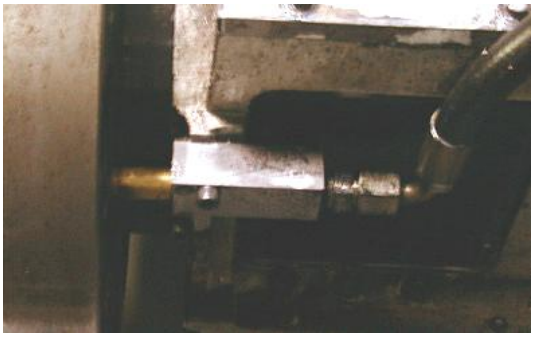
This means the ChipBLASTER EV60 (12 to 60 l/min @ 70 bar) would be the right ChipBLASTER model for the application.

"Rule of Thumb" 7.5 l/min per Cutter Insert

Special Considerations:

To date, ChipBLASTER has done modifications to over 60 different machine tool lines helping to configure them with the proper coolant volume and pressure for the application.

However, when sizing a system, it is important to take the machine tool limitations into consideration. Some manufacturers use rotary joints on the spindle, turret shafts, or other limiting components that may limit the possible flow.



Example:
The customer is using a drill that is 75mm in diameter (1.5 l/min x 75mm = 112 l/min)

Ideally we would recommend the ChipBLASTER WV2-120 for this application (24 to 120 l/min @ 70 bar) because the drill would work the best with 112 l/min coolant flow.

Upon researching the machine tool, it is found that the coolant port (inducer block) for the turret is only 4mm in diameter.

We Know:
The maximum volume that can pass is designated by the smallest orifice in the system.

But it is important for temperature control that the largest amount of volume we can provide to the tool. However, the restriction in this case is not the tool openings or high pressure coolant line size. The smallest coolant opening is 4mm (piston inside the inducer block on the rear of the turret) and will only pass 75 l/min @ 70 bar.

This means the ChipBLASTER GV2-80 (16 to 80 l/min @ 70 bar) would provide the customer the best benefit based on the limiting factors in the application/machine tool!

Possible Solution:
We can conclude that we need to connect the high pressure line directly to the cutting tool.

Possible Problem:
When connecting to the tool, it limits the mobility of the machine tool. The customer may not be able or willing to do this. Therefore, we size the ChipBLASTER based on the best scenario we have for through the tool coolant.

Multiple Spindles or Turrets:

When considering the high pressure coolant unit, it is also important to consider the number of turrets or spindles on the machine tool, as well as to make sure which (and how many) turrets or spindles will need coolant at the same time.

Example:
The customers machine tool has (2) independent cutting spindles.
Each spindle is 15 KW strong and the largest drill is 25mm in diameter.

Using our first "Rule of Thumb" above (2 l/min. per KW) we know that a 15 KW spindle needs 30 l/min for the proper application of high pressure coolant. However, this machine tool has (2) spindles that operate independently.

Therefore, we can determine that the application is really 30 KW of total energy. (15 KW spindle one and 15 KW spindle two)

Customer request is now 70 bar on two separate operating 15 KW spindles with fluid at separate times if needed which requests 2 x 30 l/min.

This means the ChipBLASTER J2-60 (30 l/min @ 70 bar ***for each side***) or GV2-80 (8 to 40 l/min @ 70 bar ***for each side***) would provide the proper amount of coolant volume for the customers application.

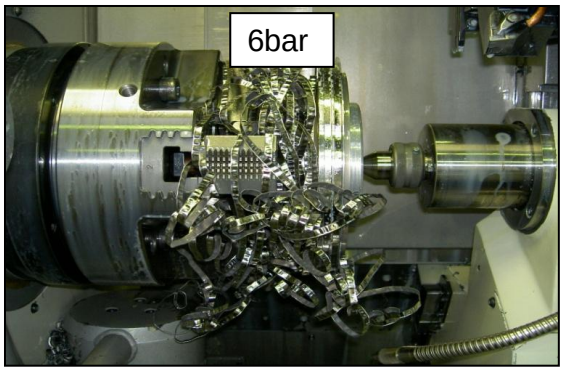
What Pressure is Needed?:

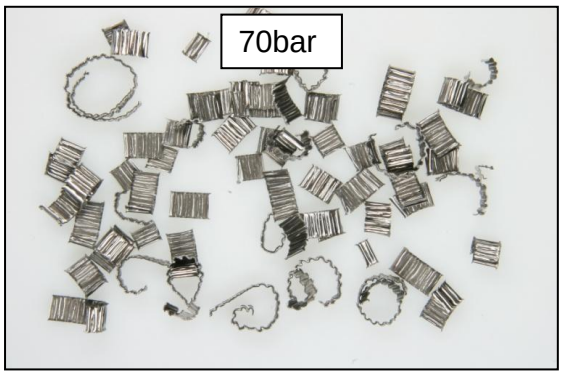
When machining different materials, there is a possibility that higher pressure may be needed to achieve the benefits of high pressure coolant. The table below shows the recommended starting pressure for different materials. It also shows what pressure may be needed in special applications:

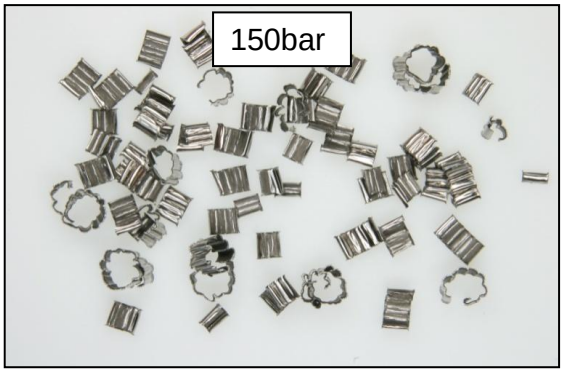
Selection of Material	Starting Point	Exception
LCS - Low Carbon Steel - (1008. 1018 usw.)	70 bar	140 bar
MCS - Medium Carbon Steel - (1045, 4130, 4340 usw.)	70 bar	103 bar
HCS - Stainless - (PH Series, 300 Series, 400 Series)	70 bar	210 bar
Aluminum	70 bar	70 bar
Copper	70 bar	70 bar
Titanium	70 bar	345 bar
Inconel	70 bar	345 bar

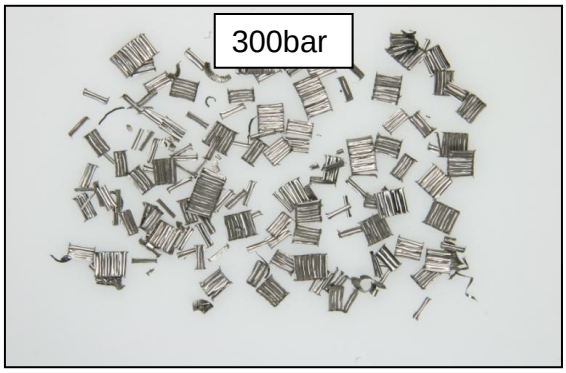
As you can see, 70 bar coolant pressure is normally enough to achieve the required effect of high pressure coolant. However, some materials, like Titanium and Inconel require a higher pressure in certain cases to effectively cool the cutting edge. But many times the tools or machine restrictions are responsible for higher pressure needs, because the higher pressure creates extra volume to compensate for the cutting tool or machine tool flow restriction.

The chart below shows differences in an application at various pressures:







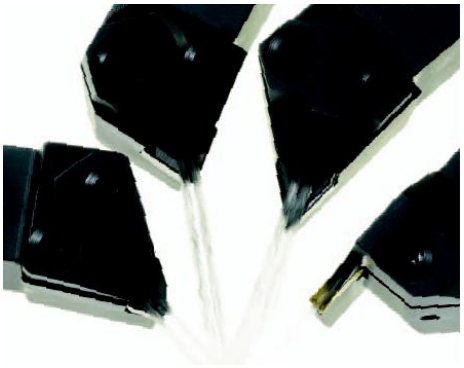


Directing the Coolant to the Tooling:

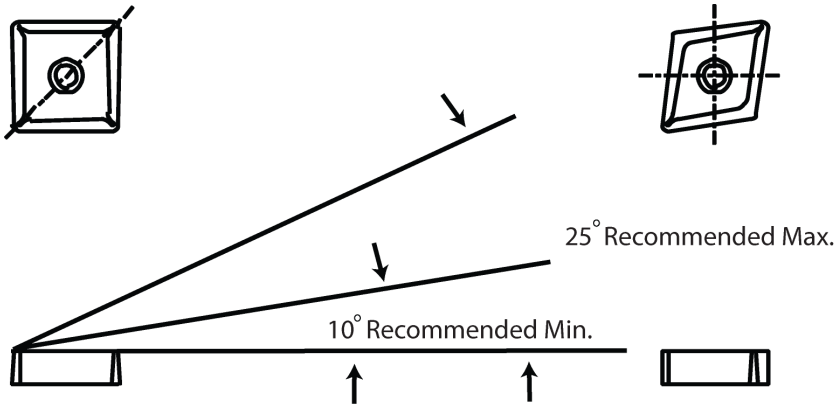
Most applications on milling machines with coolant through the spindle will allow for coolant to be directed to the cutting edge. Many tooling manufacturers offer coolant through drills, reamers, thread mills, and end mills for proper direction of the coolant.

However, in turning applications, the proper direction of the coolant to the cutting edge is more difficult.

For turning holders, manufacturers like Kennametal, SECO, ISCAR, and Sandvik, make turning holders with proper coolant direction build in. See pictures below:



The focus of the fluid should be at the chip/tool interface so that temperature control is most effective and chips are properly formed and evacuated.

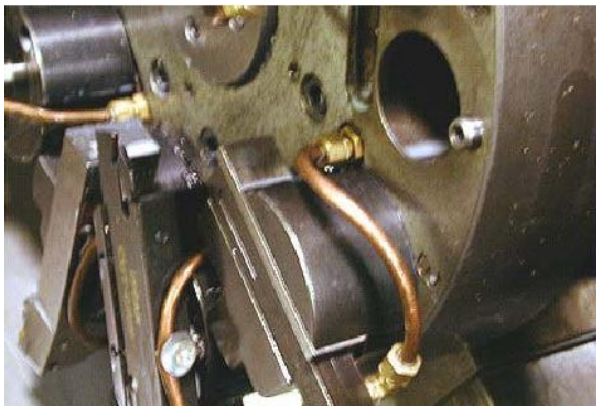


RECOMMENDED ANGLES FOR COOLANT DELIVERY WHEN
USING THE CHIPBLASTER HIGH PRESSURE/HIGH VOLUME SYSTEM

Once the turning holders are specified, it is important to make sure that the line connection from the turret to the tool is properly installed so that full coolant volume and pressure can reach the cutting edge.

Commonly, compression fittings are use to mount in the low pressure coolant outlet, and copper or steel tubing is run from that connection point to the compression fitting on the turning holder.

Picture shown below:



Note: <u>It is important to minimize the number of bends or kinks in the line. Bends and kinks limit the coolant flow and pressure at the cut point.</u>

Interfacing and "M" code connection:

The ChipBLASTER unit will require 1 set (pair) of ***latching*** "m" codes for on/off control of the main coolant pump. On our standard models, the transfer pump should be included and is controlled inside the ChipBLASTER for return of fluid from the machine tool back to the ChipBLASTER.

Example: Issue M88 to turn coolant on and M9 to turn coolant off.

If the customer wants to control (2) separate outlets, they would need to have (2) sets (pairs) of latching "m" codes for on/off control of each outlet.

Example: Coolant outlet (1) uses M88 and M9 for control and Coolant outlet (2) uses M51 and M52 for control.

The same can be said if the customer wants preset pressures for different set points in the operation. The ChipBLASTER can have (4) preset pressures and ***requires (1) set (pair) of latching "m" codes for every preset*** to operate them.

The ChipBLASTER also requires 3 phase external power for operation. The best way to power the ChipBLASTER is by pulling power from a power bus (drop down to the machine). It is important to make sure that the power source can handle the amperage draw (KVA) of the ChipBLASTER.

Important ChipBLASTER Patent

United States Patent:

Seal for a reciprocating plunger (High-Pressure Pump)
United States Patent: 6,776,419

Abstract:
A seal for a reciprocating plunger is formed of a hard polyimide plastic, rather than the relatively soft elastomers of earlier seals. The present seal has a conical section, with the tapered face fitting closely within the mating conical face of a hard metal retainer. An O-ring resides in a groove within the seal to provide low pressure sealing between the plastic seal and the metal retainer. The tapers of the seal and retainer urge the seal inwardly toward the plunger by operational pressures, thereby providing a better seal. The present seal provides greatly extended life over softer prior art seals and will generally last for the life of the pump or other mechanism in which it is installed. Yet, the plastic material allows some flow under high pressures, allowing the seal to conform closely to the plunger surface during operation and throughout the life of the seal.

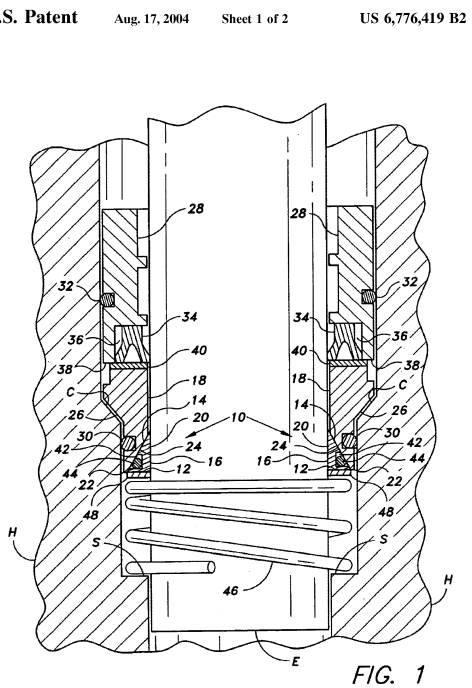


FIG. 1

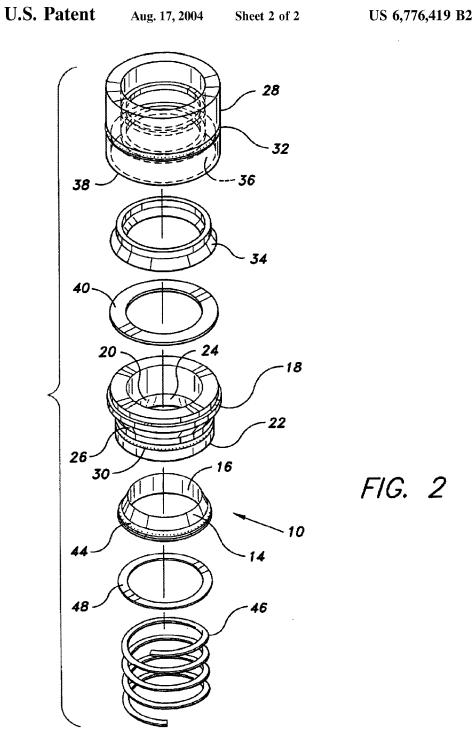
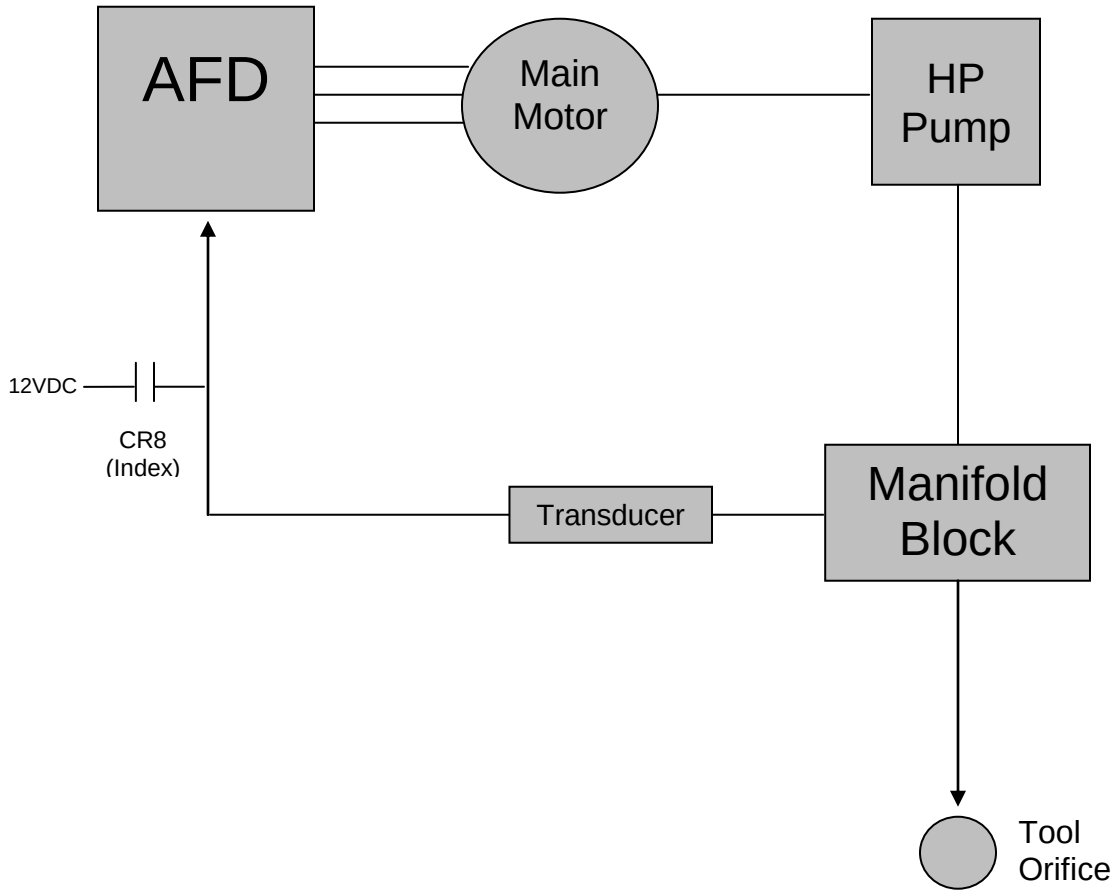


FIG. 2

United States Patent:

Programmable, variable volume and pressure, coolant system
United States Patent: 5,951,216

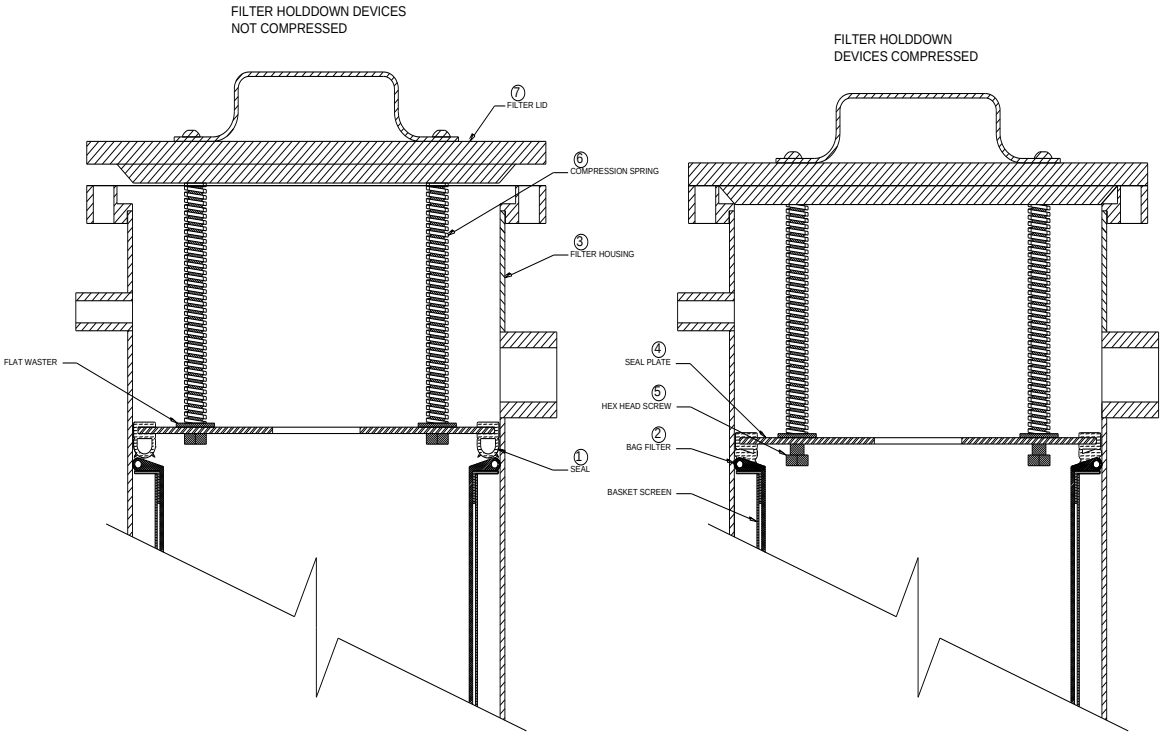
Abstract:
A programmable, variable volume and pressure, coolant system regulating the amount of coolant flow to a cutting tool by controlling the speed of a coolant pump, and it's comprised of a fluid control unit and an electrical control panel. The fluid control unit includes a pump and an AC pump motor operatively connected thereto. The electrical control panel includes: a power supply; circuit breakers; a computer; a variable frequency drive; control relays; and a junction block for making electrical connections to the control panel. The computer receives signals from the tool and a pressure transducer, and is programmed with information concerning the total flow area of the coolant orifices. Using this information, the computer determines an ideal pump speed, and sends a control signal to the variable frequency drive which in turn determines the pump motor speed. The coolant supply system also includes: a coolant supply line for routing coolant from the pump to the tool; a catch pan for collecting recycled coolant from the tool; a filter for removing impurities from the used coolant; a reservoir for storing coolant; and a return line for routing the recycled coolant to the reservoir and from the reservoir to the pump inlet.



United States Patent:

Double compression filter hold down
Patent No. 7,959,803

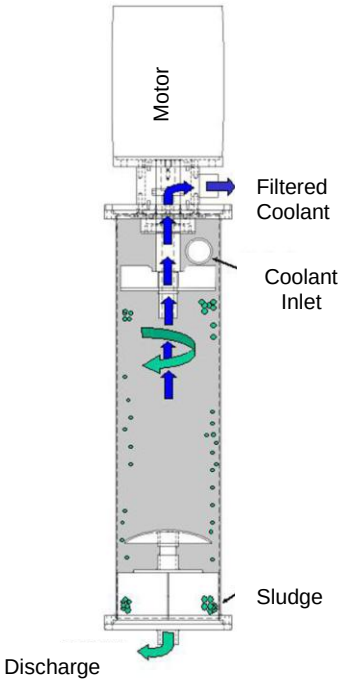
Abstract:
A devise for securing a filter element within a housing of a separation system, wherein the housing has an inner wall and includes therein a filter seating to seat the filter element, includes at least one sealing member adapted to form a sealing connection with the filter element and a sealing connection with the inner wall of the housing. The device further includes at least one compression member to compress the elastomeric sealing member to from the sealing connection with the filter and the sealing connection with the inner wall of the housing.

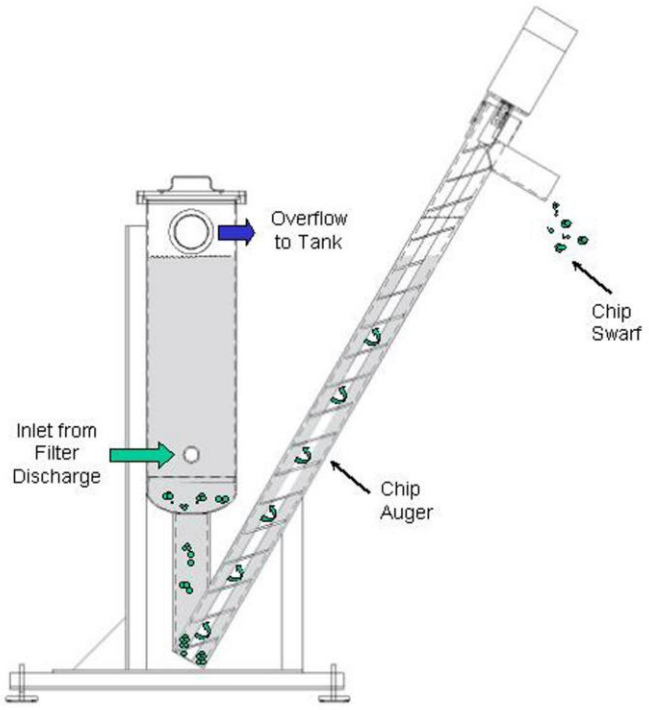


United States Patent:

Cyclonic filter assembly
Patent No. 5,879,545

Abstract:
A compact cyclonic filter assembly used for separating unwanted debris from a fluid. The cyclonic filter assembly uses the centrifugal forces to separate large pieces for debris from the fluid and a filter to separate the remaining unwanted debris from the fluid. The present invention can be contained in a compact single housing which may be disassembled for easy cleaning and replacement of parts. The cyclonic filter assembly of the present invention has a vertically oriented cylindrical tube which receives a tangential injection of the debris laden fluid. The tangential injection causes the fluid to circulate around a cylindrical vortex finder which is inside of and coaxial with the tube. The centrifugal forces acting on the debris causes the debris to move outward away from the center of the vortex. The vortex finder has an opening which pulls in the relatively clean fluid near the center of the vortex while the debris laden fluid settles into a collection chamber below the cylinder tube. The vortex finder carries the relatively clean fluid to a filtration chamber which preferably encircles the cylindrical tube.



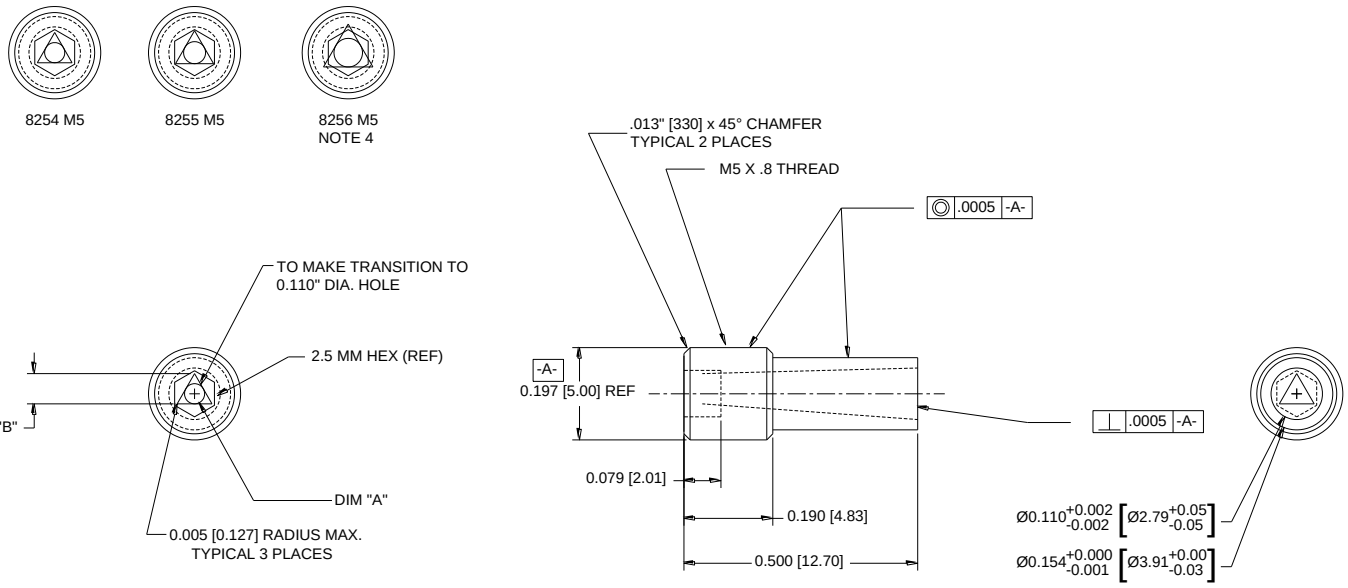


United States Patent:

Tool holder with integral coolant passage and replaceable nozzle
United States Patent: 6,045,300

Abstract:
A tool holder for holding cutting inserts for machine tool work includes an integral cooling passage therethrough. Various coolant nozzles are interchangeably installable in the holder, to provide different amounts of coolant fluid flow depending upon the specific work being accomplished. The portion of the cooling passage in the tool holder adjacent to the installed nozzle, as well as the nozzles, are devoid of bends or changes in direction of the coolant flow path for greater efficiency and to ensure that the coolant flow is directed precisely at the cutting tip of the insert regardless of the radial orientation of the nozzle. The nozzles each incorporate a non-circular, preferably triangular, coolant outlet tip, which cross sectional shape blends smoothly with the circular cross sectional shape of the nozzle inlet and passage through the tool holder. The triangular cross section of the latter portion and outlet of the nozzle passage precludes any significant circumferential flow vector of the fluid flowing therethrough and flattens the sides of the fluid stream, thus precluding any significant pressure drop along of the stream or expansion due to centrifugal reaction which would tend to pull the stream apart. The result is a cohesive stream which maintains its fluid force as it passes through the air from the nozzle to the insert cutting edge and work piece. The tool holder may be adapted for use as a stationary holder for use with rotating work pieces, or as a rotating holder for use with relatively stationary work piece.

Nozzle Illustration:



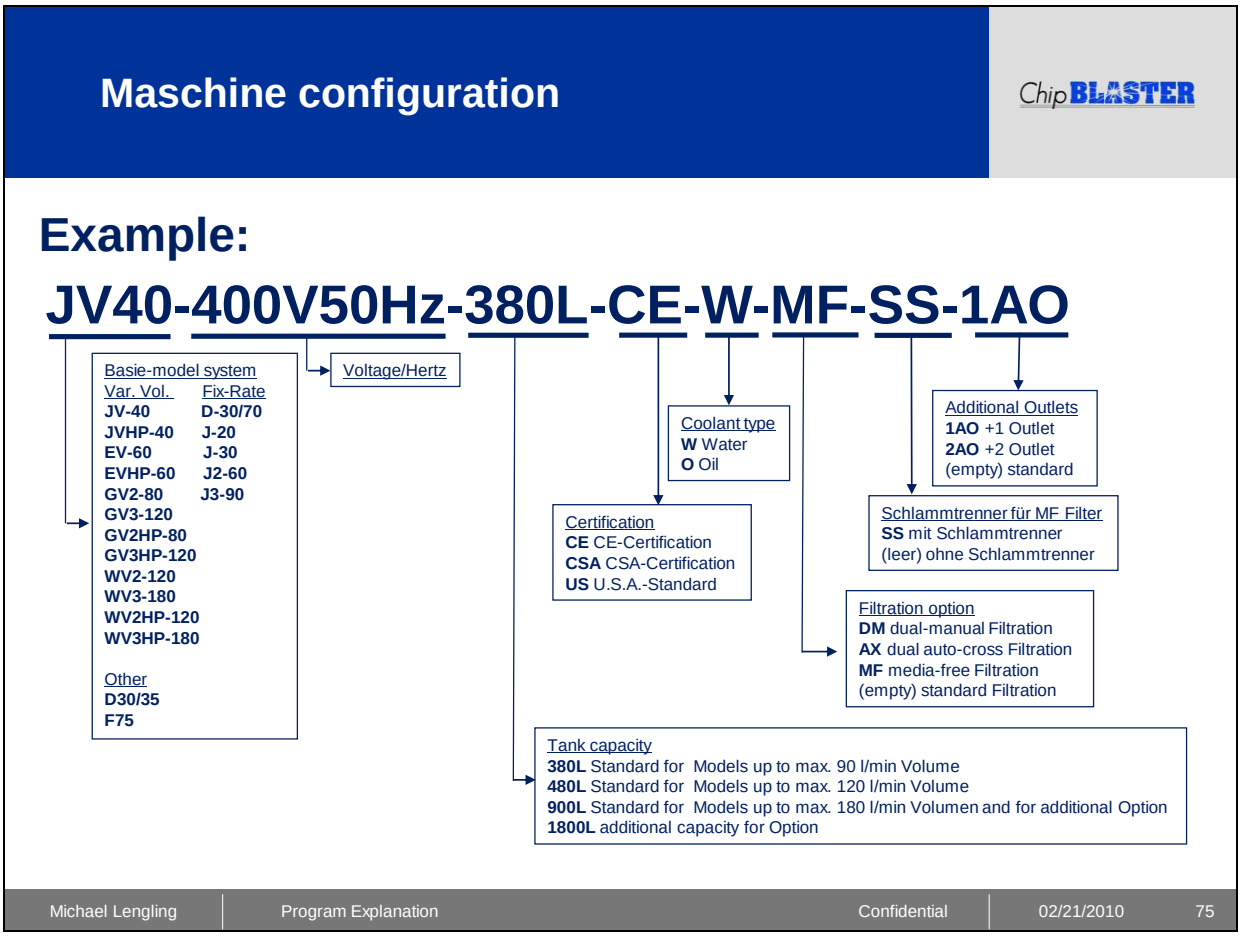
PART No.	DIM. "A"	DIM. "B"	AREA
8254 M5	0.043" [1.092]	0.065" $^{+\ 0.001"}_{-\ 0.001"}$ [1.651 $^{+\ 0.025}_{-\ 0.025}$]	.0024 (SQ. IN.)
8255 M5	0.047" [1.194]	0.070" $^{+\ 0.001"}_{-\ 0.001"}$ [1.778 $^{+\ 0.025}_{-\ 0.025}$]	.0028 (SQ. IN.)
8256 M5	0.061" [1.549]	0.091" $^{+\ 0.001"}_{-\ 0.001"}$ [2.311 $^{+\ 0.025}_{-\ 0.025}$]	.0049 (SQ. IN.)

NOTES:
1. ALL DIAMETERS TO BE CONCENTRIC WITH IN 0.002" T.I.R.
2. MATERIAL: 440 STAINLESS STEEL.
3. HEAT TREAT: 56 - 58 ROCKWELL "C" THROUGH.
4. PART No. 8256 TRIANGLE WILL BREAK OUT OF HEX.

Machine Nomenclature

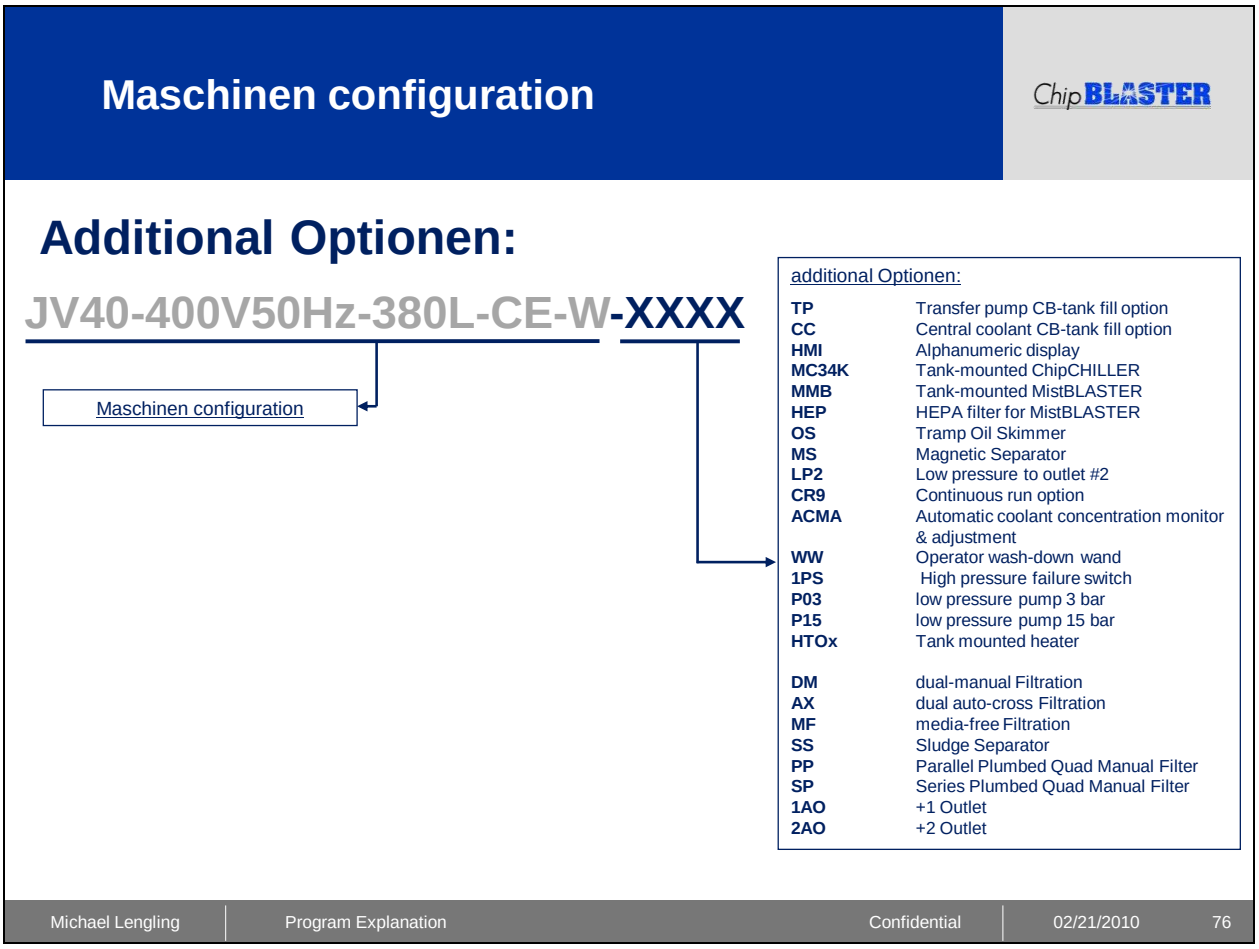
Nomenclature for Machine Configurations:

ChipBLASTER machine nomenclature identifies the base model coolant system, voltage, certification, coolant type, tank capacity, filtration, and number of outlets. Additional options may also be defined.



Nomenclature for Additional Options:

Nomenclature for additional options are added to the nomenclature for machine configurations as required for the individual application. When an option is not required, the abbreviation is simply omitted.

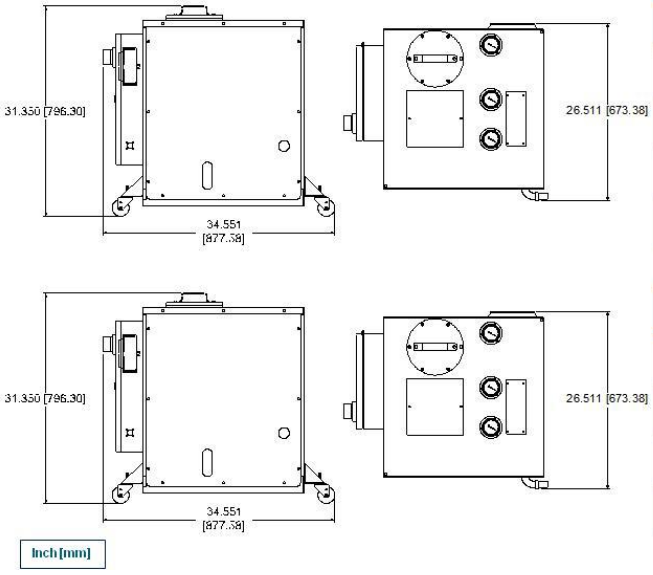


Machine Configurations

Fixed Rate Systems:

ChipBLASTER fixed rate base "D" or "J" models are defined according to flow in l/min., pressure in bar, and number of outlets. "D" and "J" models allow for a manual adjustment of the pressure setting. These machines supply at the set rate without automatic volume variation.

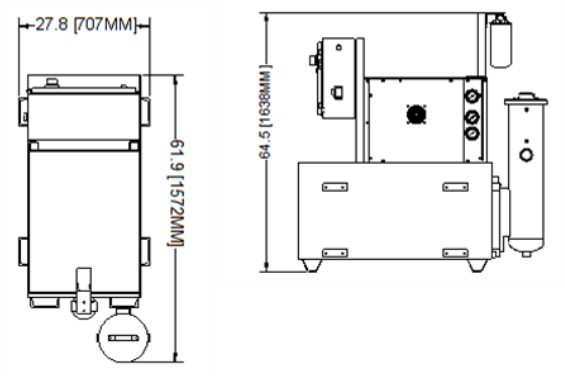
ChipBLASTER D-30/35 and D-30/70



Model	D-30/35
Pressure	35 bar
Volume	30 l/min.
Reservoir	N/A
Motor Power	7,5 PS

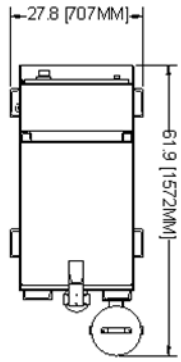
Model	D-30/70
Pressure	70 bar
Volume	30 l/min.
Reservoir	N/A
Motor Power	7,5 PS

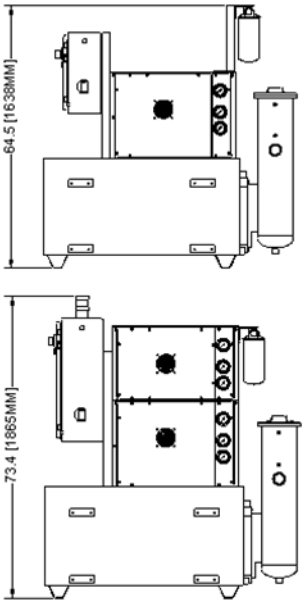
ChipBLASTER J-20



Model	J-20
Pressure	140 bar
Volume	20 l/min.
Tank	380 Liter
Motor Power	7,5 PS

ChipBLASTER J-30 and J2-60



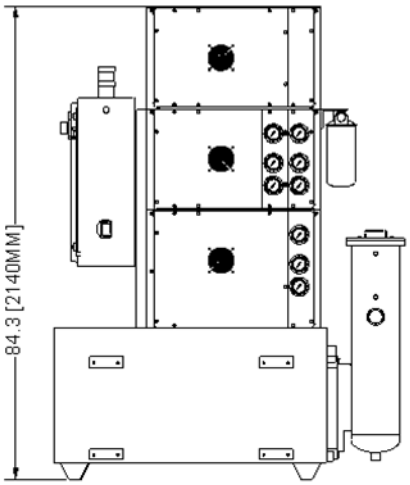


Model	J-30
Pressure	70 bar
Volume	30 l/min.
Tank	380 Liter
Motor Power	7,5 PS

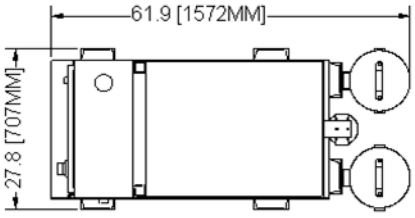
Model	J2-60
Pressure	70 bar
Volume	2 x 30 l/min.
Tank	380 Liter
Motor Power	2 x 7,5 PS

Inch [mm]

ChipBLASTER J3-90



Model	J3-90
Pressure	70 bar
Volume	3 x 30 l/min.
Tank	380 Liter
Motor Power	3 x 7,5 PS

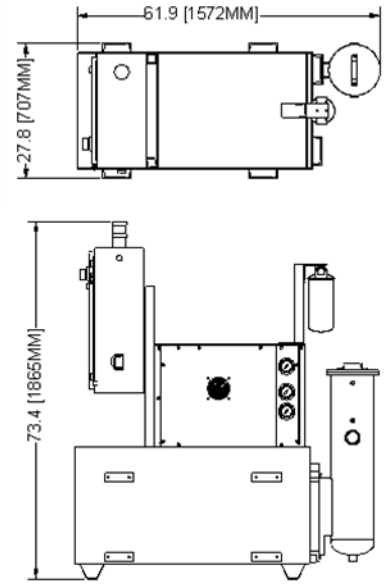


Inch [mm]

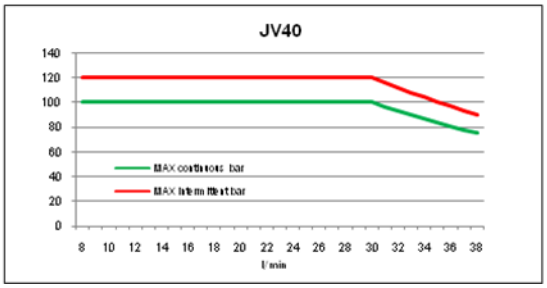
Automatic Variable Volume Systems:

ChipBLASTER automatic variable volume systems or "V" models are defined according to range of supplied flow in l/min., pressure range in bar, and number of outlets. "V" models utilize ChipBLASTER's patented automatic variable volume technology. These machines are controlled by a Programmable Logic Controller (PLC) and the motor is regulated by an Adjustable Frequency Drive (AFD). This allows the unit to self-regulate the amount of power needed to attain the pressure called for by the machining application.

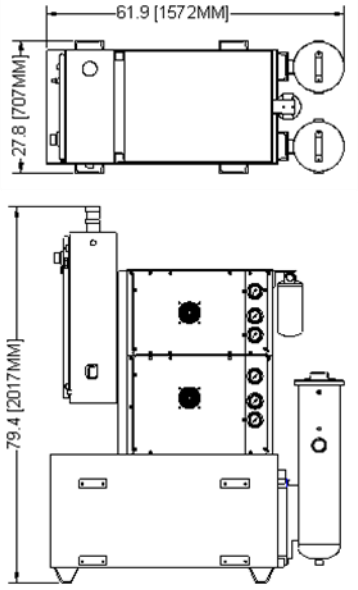
ChipBLASTER JV40



Model	JV40
Pressure	Up to 100 bar
Volume	11 to 40 l/min.
Tank	380 Liter
Motor Power	7,5 PS

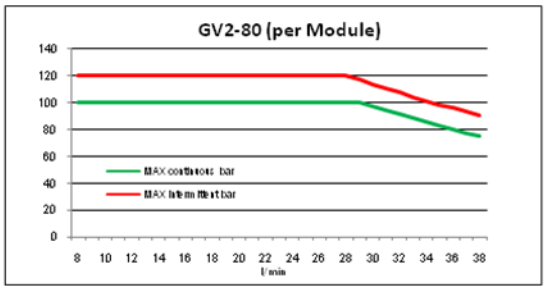


ChipBLASTER GV2-80

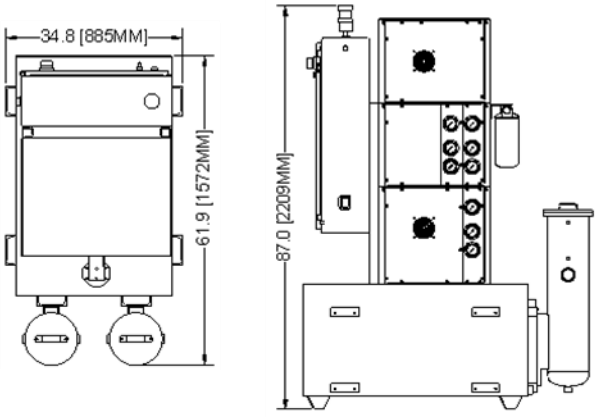


Inch [mm]

Model	GV2-80
Pressure	Up to 100 bar
Volume	2 x 8 to 40 l/min.
Tank	380 Liter
Motor Power	2 x 7.5 PS

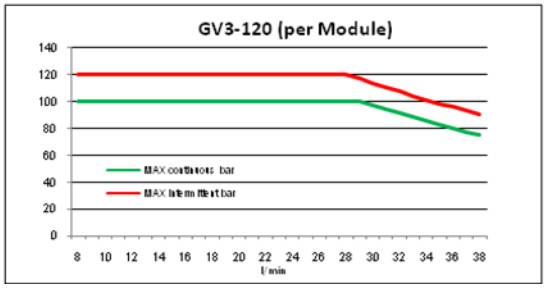


ChipBLASTER GV3-120

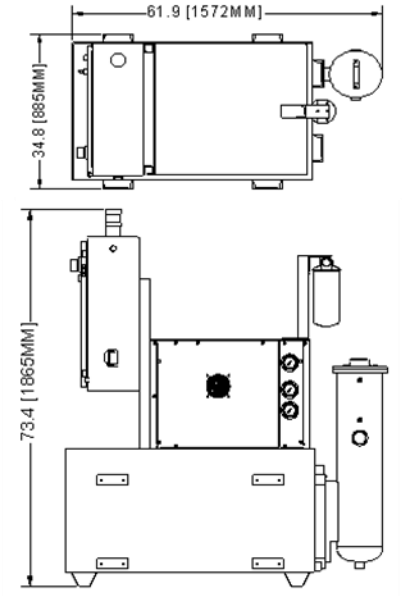


Inch [mm]

Model	GV3-120
Pressure	Up to 100 bar
Volume	3 x 8 to 40 l/min.
Tank	480 Liter
Motor Power	3 x 7.5 PS

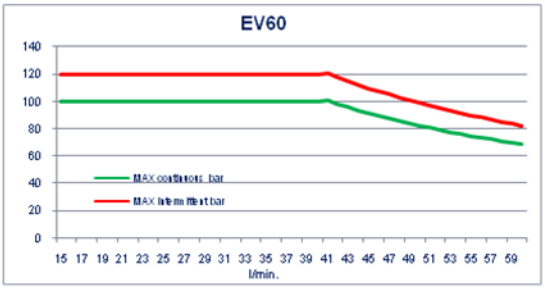


ChipBLASTER EV60

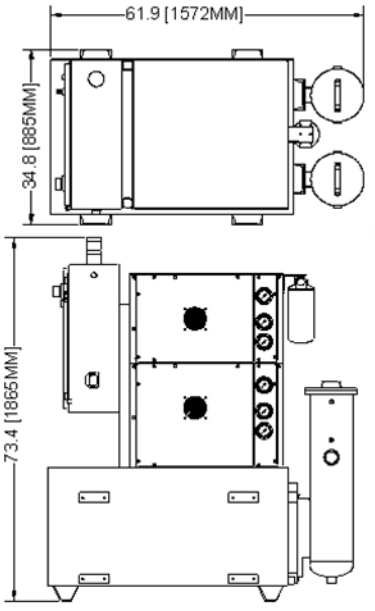


Inch [mm]

Model	EV60
Pressure	Up to 100 bar
Volume	12 to 60 l/min.
Tank	480 Liter
Motor Power	10 PS

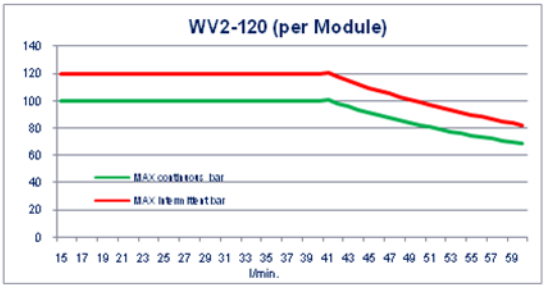


ChipBLASTER WV2-120

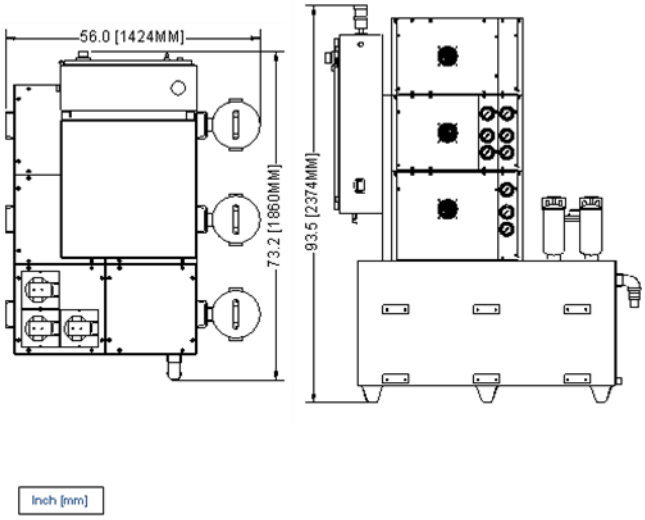


Inch [mm]

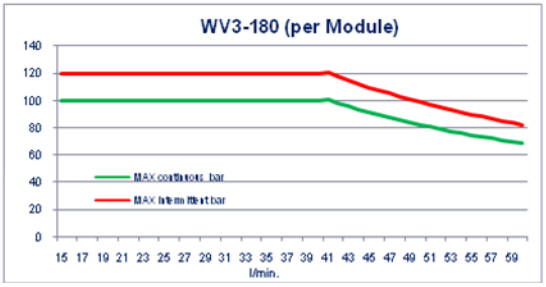
Model	WV2-120
Pressure	Up to 100 bar
Volume	2 x 12 to 60 l/min.
Tank	480 Liter
Motor Power	2 x 10 PS



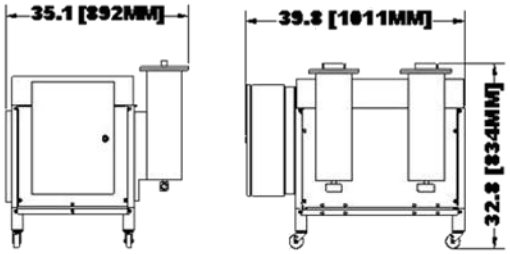
ChipBLASTER WV3-180



Model	WV3-180
Pressure	Up to 100 bar
Volume	3 x 12 to 60 l/min
Tank	900 Liter
Motor Power	3 x 10 PS

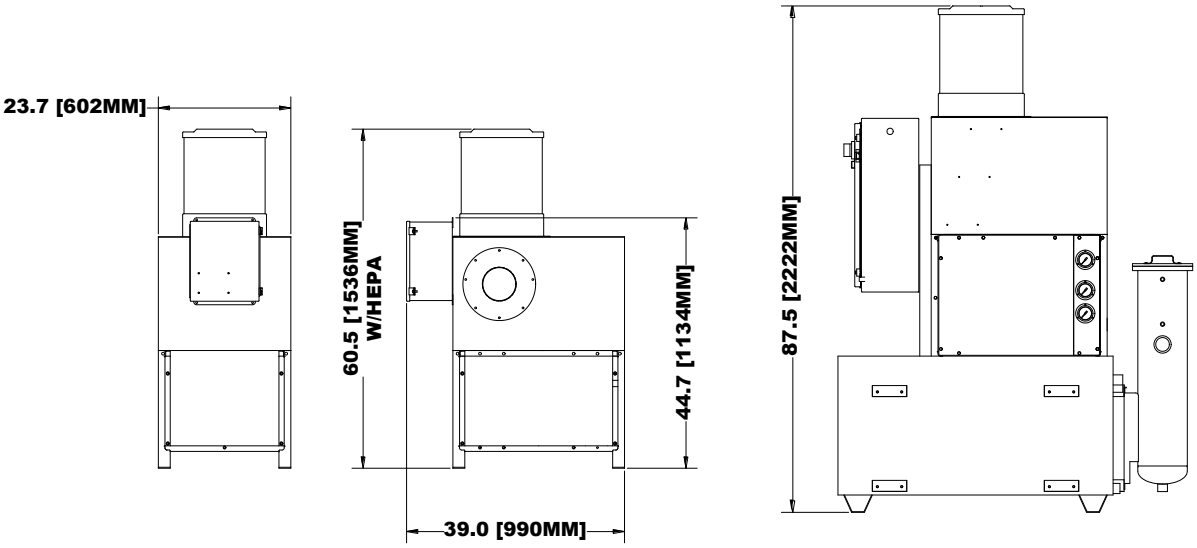


ChipCHILLER 34K



Model	34K
Power	10.000 Watt
Volume	Up to 60 l/min.
Reservoir	N/A
Motor Power	1 PS

Mist Collection System
(MistBLASTER)



Specifications:

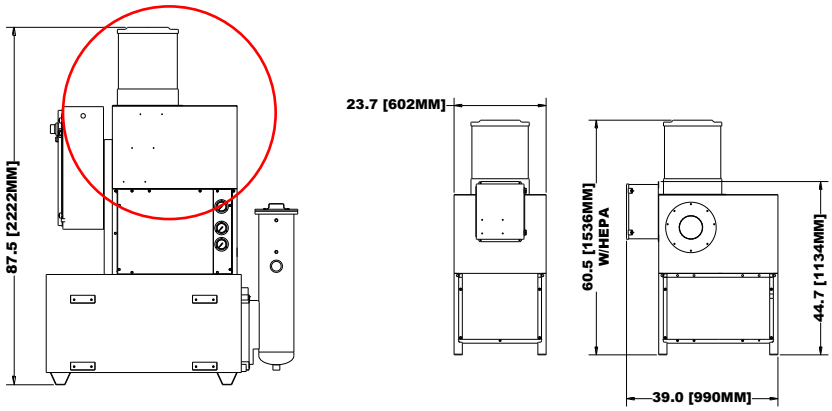
Max Meter^3/Minute	**34 (1200 cfm)**
Amperage	**5 amps @ 240 VAC**
Remote Location	**Yes**
Liquid Return	**Yes**
Air Quality	**Outstanding**
Weight	**102 Kg. (225 lbs)**

"M"-Code controlled.

HEPA Filter for MistBLASTER (HEPA):
HEPA filter mounted to MistBLASTER, further reduces exhausted mist.

Popular Options and When to Use Them:

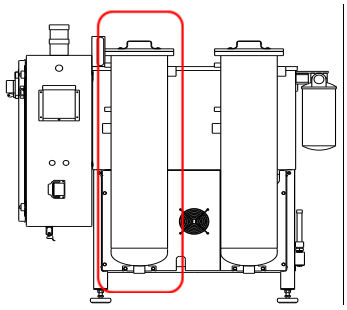
The **MistBLASTER** mist collection unit is designed to collect the atomized coolant particles and to filter them to clean the air. With (2) set points, it operates at a higher efficiency than fixed rate mist collectors and provides a better end result (less operator exposure) with additional reduced energy needs and costs. The MistBLASTER is available as an independent model or as a ChipBLASTER accessory.



Dual Manual Filter (DM):
The most popular options are the dual filtration or automatic filter crossover options. These items are commonly used in applications where the material, run time, or other parameter makes them needed as explained in the following example:

The customer is cutting aluminum and is running the equipment 2 shifts per day and 7 days a week. They also don't have a maintenance staff available on the second shift.

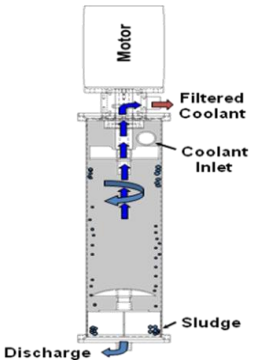
This is an ideal scenario to add the dual filter option. This will allow the operator to move a ball valve to change from filter "A" to Filter "B" and keep the machine running until the maintenance crew is back in to change the filter in case a filter alarm occurred.



In the case where a customer is running 24 hours a day 7 days a week, it would be also sufficient to discuss the automatic filter crossover option. This option will automatically change from dirty filter "A" to clean filter "B" without human intervention. This allows the machine to continue to run and eliminates possible down time caused by the dirty filter alarm.

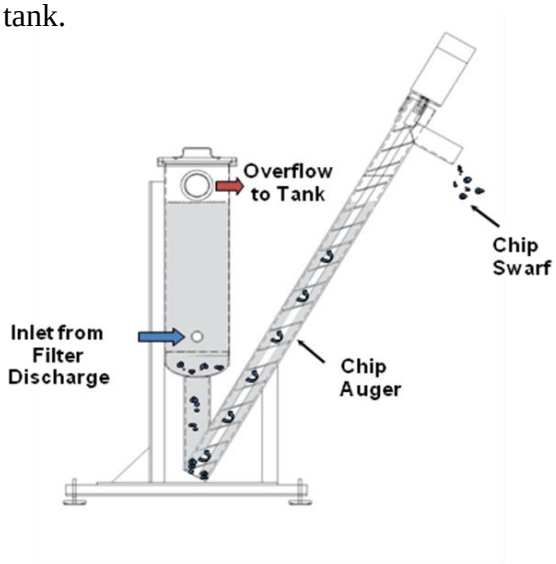
Media Free Filter (MF):
In addition to the filtration options above, ChipBLASTER offers the media-free filtration option as another possibility. It continually filters fluids through the large capacity centrifuge for high-pressure and low-pressure coolant. Coolant is pressure fed by the transfer pump to the coolant inlet. The coolant is then spun by the centrifuge unit and all particulates are separated and collected beneath a baffle in the base of the filter. All clean coolant is forced through the center of the swirling fluid to the ChipBLASTER reservoir. The dirty coolant sludge is then discharged through the base of the filter to either your settling tank or the optional ChipBLASTER Sludge Separator. An independent laboratory has found this filtering system to be 98.75% effective in filtering particulates down to 2 micron.

The media free filter unit is used in many applications but is ideal for scenarios where the customer is machining a heavy chip making material and needs the ability to eliminate down time associated with filter changes.

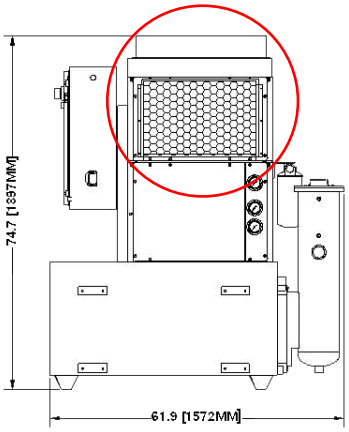


Many customers machining "cast iron or ductile iron" use the media free unit to provide excellent filtration and maximum up time.

Sludge Separator (SS):
A settling device which further dewaters Media Free Filter discharge sludge before dumping to machine center conveyor or holding container. For discharging particulates, the sludge separator option is added as an accessory to the media free unit. The sludge separator further separates coolant and chips in a settling tank.



ChipCHILLER (MC 34K) or (SA 34K):
The ChipCHILLER is used to control temperature in the machining process. ChipBLASTER offers a standard 10.000 Watt complete with ambient tracking controller (coolant temperature tracks ambient temperature at a constant, adjustable differential, displays both ambient & coolant temperature), automatically controls tank coolant temperature to within +/- 0.3°C of set point. Mounted or stand alone ChipCHILLER are best used in applications where the customer is machining exotic materials, meets very tight tolerances on their parts, or has a small total coolant volume.



Human Machine Interface (HMI):
A Message center with a 2-line, 40-character display mounted on ChipBLASTER enclosure door, displays unit faults/errors in plain language

Additional Outlet Options:

One Additional Outlet (1AO):
One (1) additional outlet with same nominal size and hose length as base unit, complete with indexing capability, controlled by Machine Center m-codes.

Two Additional Outlets (2AO):
Two (2) additional outlets with same nominal size and hose length as base unit complete with indexing capability, controlled by Machine Center "m" codes.

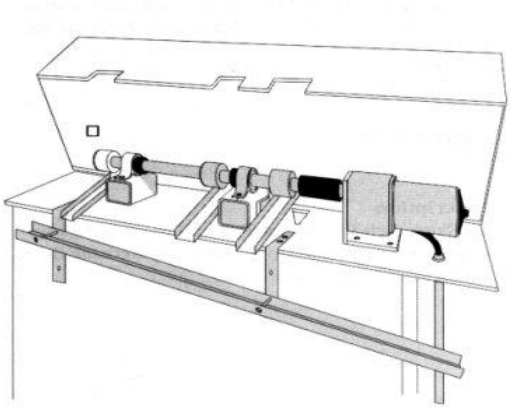
Tank Fill Options:

Transfer Pump (TP):
An appropriately sized coolant pump for filling the ChipBLASTER unit with all options, complete with suction standpipe assembly for Machine Center sump, controlled by the ChipBLASTER unit.

Central Coolant Supply (CC):
A pressure regulator coupled to an in-line solenoid valve, connected to ChipBLASTER tank inlet. Valve is activated by the ChipBLASTER when tank level drops and tank make-up coolant is required. Central supply limited to 27 bar, 82°C.

Other Value Added Options:

Tramp Oil Skimmer (OS):
Belt style skimmer. Various configurations available for tank mounted units. Adjustable timer limits skimmer run time to minimize water content in disposed oil. Capable of removing from 3.8 to 15.2 liters/hour of medium weight oil from water base coolants. Indicate desired oil removal rate (liters/hour) within parentheses. (3.8 to 7.6 l/h = 0.25 & 7.7 to 15.2 l/h = 0.5 option count units)



Magnetic Separator (MS):
A magnetic particle remover which greatly reduces filter load and increases filter life. Typically used in cast iron applications.

Low Pressure on Outlet 2 (LP2):
Allows low pressure coolant (2.4 bar) to outlet two. Can be used simultaneously with high, or standard low, pressure on outlet one. Controlled by Machine Center m-code.

Continuous Run Option (CR9):
Signal starts high pressure pump, allows for instantaneous coolant flow upon call-for-coolant signal. Controlled by Machine Center m-code.

Other Value Added Options:

Auto Coolant Concentrate Monitor & Adjust (ACMA):
Automatically controls coolant concentration levels within +/- 1%. The system can be set to measure the coolant concentrate level every 5 to 30 minutes and corrects concentrate to an electronically preprogrammed set point.

Operator Wash-down Wand (WW):
Hand held adjustable spray nozzle on 6m long hose, timed operation (adjustable in PLC) with enclosure mounted push-button start.

High Pressure Failure Switch (1PS):
Senses low pressure at ChipBLASTER outlet causing error signal to Machine Center and e-stop ChipBLASTER. Typically set at 21 bar unless otherwise specified.

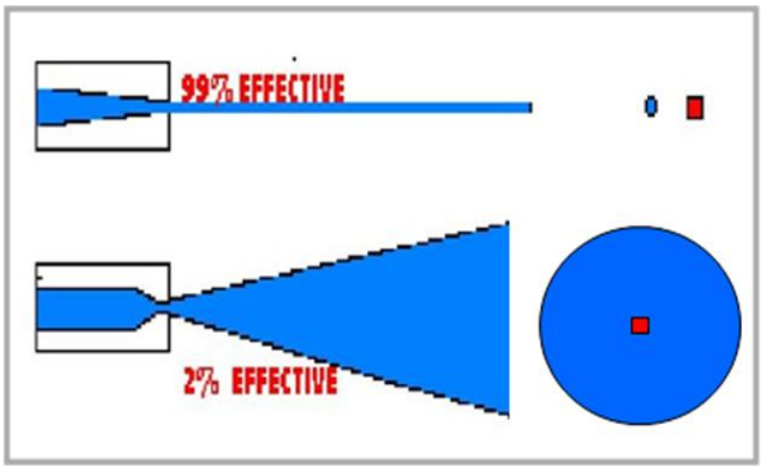
Pump, 3 bar (P03):
Coolant flow to max. 76 l/min.
Pressure to max. 3 bar
1x Ø25.0 mm Coolant outlet, L = 4.5m
Controlled by machine center m-code

Pump, 15 bar (P15):
Coolant flow min. 11 l/min. to max. 64 l/min.
Pressure to max. 15 bar
1x Ø19.0 mm Coolant outlet, L = 4.5m
Controlled by machine center m-code

Nozzles – Power on the spot!

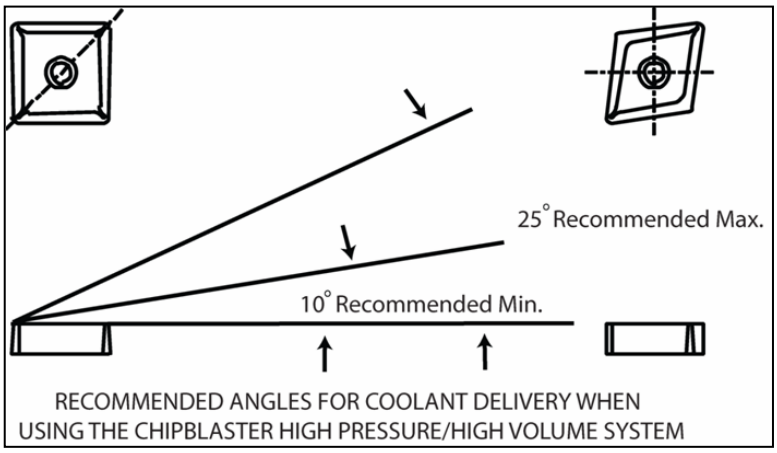
As mentioned before, the focus of the fluid should be at the chip/tool interface so that temperature control is most effective and chips are properly formed and evacuated.

The patent ChipBLASTER nozzle help I this process. Find the right nozzle size in the appendix at the end of this publication.



Hitting the target:

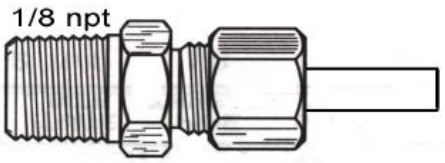
- Match coolant stream to target size
- Harder material = small target
- Same flow with smaller orifice
- Increased pressure required



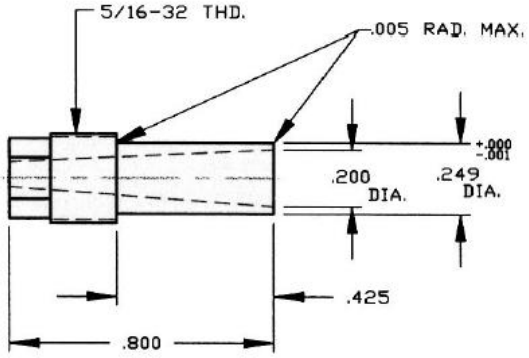
Positioning the nozzle:

- Directly at the cutting edge
- 10º angle off the face of the insert
- No greater than 25º angle
- ≥45º forces chip back into the cut

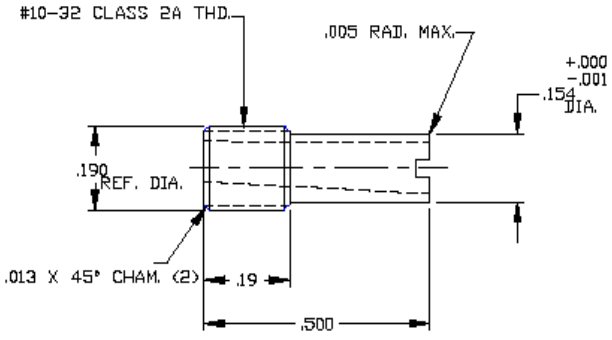
ChipBLASTER Nozzle Information:



NOZZLE NUMBER	Orifice Area (mm^2)	Liters per Minute @ 70 bar	Liters per Minute @ 138 bar	Liters per Minute @ 207 bar
8054	1.57	9.3	13.2	16.0
8055	1.82	10.8	15.2	18.5
8056	3.15	18.6	26.3	32.0
8057	4.45	26.3	37.2	45.2
8058	8.90	52.6	74.4	90.5



NOZZLE NUMBER	Orifice Area (mm^2)	Liters per Minute @ 70 bar	Liters per Minute @ 138 bar	Liters per Minute @ 207 bar
8154	1.57	9.3	13.2	16.0
8155	1.82	10.8	15.2	18.5
8156	3.15	18.6	26.3	32.0
8157	4.45	26.3	37.2	45.2
8158	8.90	52.6	74.4	90.5



NOZZLE NUMBER	Orifice Area (mm^2)	Liters per Minute @ 70 bar	Liters per Minute @ 138 bar	Liters per Minute @ 207 bar	TYPE
8254	1.57	9.3	13.2	16.0	Standard
8254R	1.57	9.3	13.2	16.0	Reverse Thread
8254M	1.57	9.3	13.2	16.0	Metric Thread
8254M5R	1.57	9.3	13.2	16.0	Reverse Metric
8255	1.82	10.8	15.2	18.5	Standard
8255R	1.82	10.8	15.2	18.5	Reverse Thread
8255M	1.82	10.8	15.2	18.5	Metric Thread
8255M5R	1.82	10.8	15.2	18.5	Reverse Metric
8256	3.15	18.6	26.3	32.0	Standard
8256R	3.15	18.6	26.3	32.0	Reverse Thread
8256M	3.15	18.6	26.3	32.0	Metric Thread
8256M5R	3.15	18.6	26.3	32.0	Reverse Metric

Modularity of Tank Unit Construction and Option Count Units:

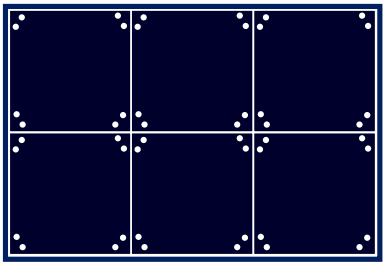
The modular design of ChipBLASTER tank units allows for a multitude of variations to unit design without time-consuming engineering expenditures and extra costs to the customer. Utilizing the symmetrical construction of our tank plates, we can configure additional options on a tank unit per customer wish. The space requirement is measured in "Option Count Units", and each tank size in combination with machine configuration allows for a predetermined sum of "option count units" at the customer's disposal.

Tank Model

ChipBLASTER

Modularity & Option Count Units ChipBLASTER Tank-Model

Example 900l Tank



4 Modular Plates
50.5 cm x 50.5 cm

Option 900l Tank : 153 cm x 102 cm (6 Modular Plates)
Option 1800l Tank : 205 cm x 154 cm (12 Modular Plates)

Maschine Configuration	Max. Option Counts (per Unit)	Additional Optionen	Req'd Option Count (per Unit)
JV40/JVHP, 900l	2.0	MC34K	N/A
JV40/JVHP, 1800l	8.0	MMB	1.5
EV60/EVHP, 1800l	8.0	HEP	N/A
GV/GVHP Model, WV/WVHP Model, 900l	0.5	OS	0.25-0.5
GV/GVHP Model, WV/WVHP Model, 1800l	6.5	LP2	N/A
J Model, 900l	2.25	CR9	N/A
J Model, 1800l	8.25	ACMA	N/A
		WW	0.5
		1PS	N/A
		P03	0.5
		P15	1
		HTOx	1.5

- Symmetrical Design allows for multitude variants without engineering expenditures and extra cost to the customer.
- Utilize "Maximum Option Count" per machine configuration to determine maximum possible additional options based upon size of tank.

Michael Lengling | Program Explanation | Confidential | 02/21/2010 | 77

Electrical Standards

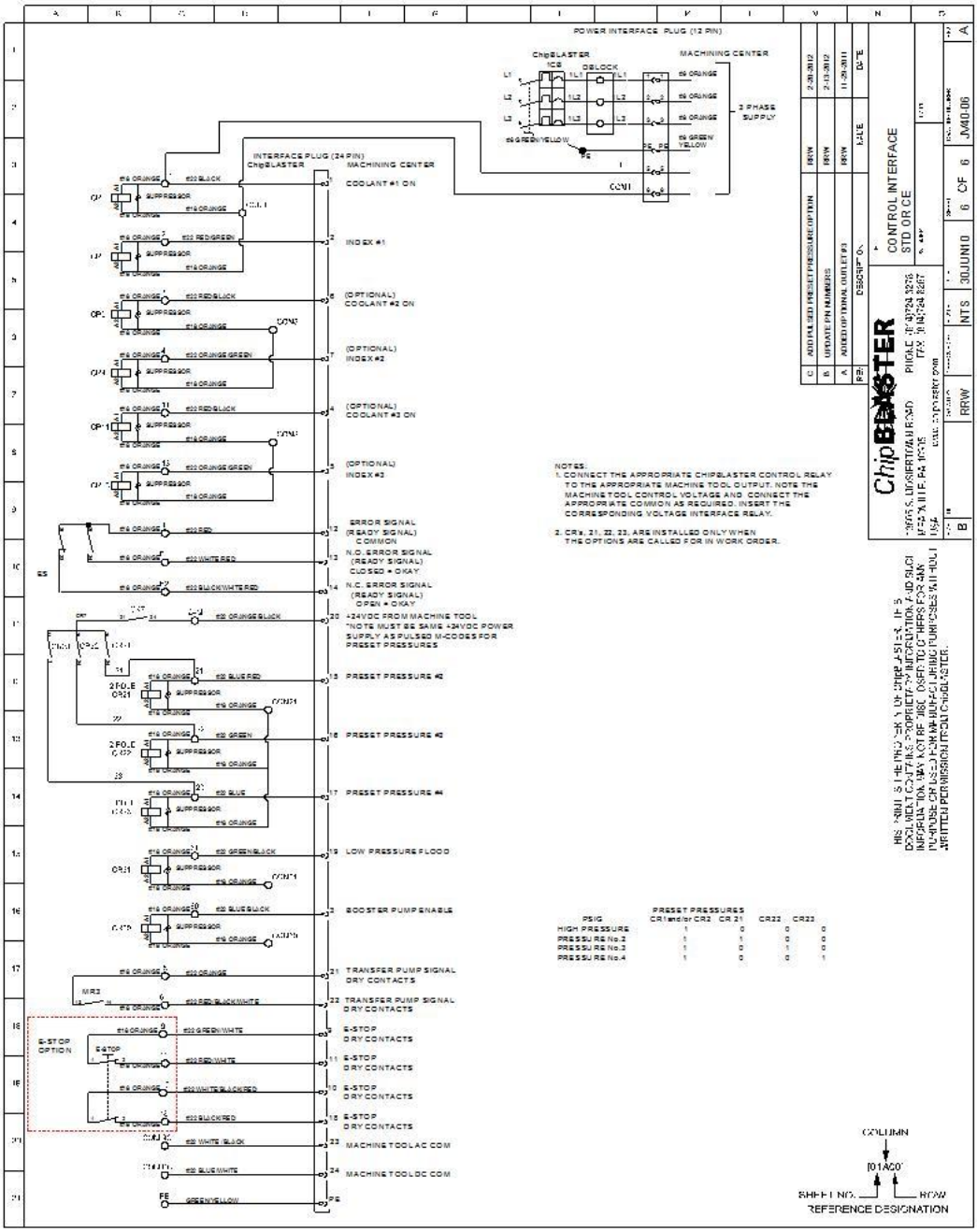
ChipBLASTER produces High Pressure / High Volume Coolant Systems according to CE standards and are manufactured under EN 61000-6-4 and EN 61000-6-2. The CE marking certifies that a product has met EU consumer safety, health or environmental requirements and shows conformity to the Machinery Directive, to EN60204-1: Safety of Machinery; EN 14121-1; 13850; 61310-2: Hazard Analysis; Airborne Noise Emissions; EN982: Safety requirements of Fluid Power Systems.

ChipBLASTER Inc. has gained CSA approval for their High Pressure / High Volume Coolant Delivery Systems. The approval Certificate 1787988 cover products in CLASS 3881 84 – TOOLS – Machine – Certified to US Standards and CLASS 3881 04 – TOOLS - Machine

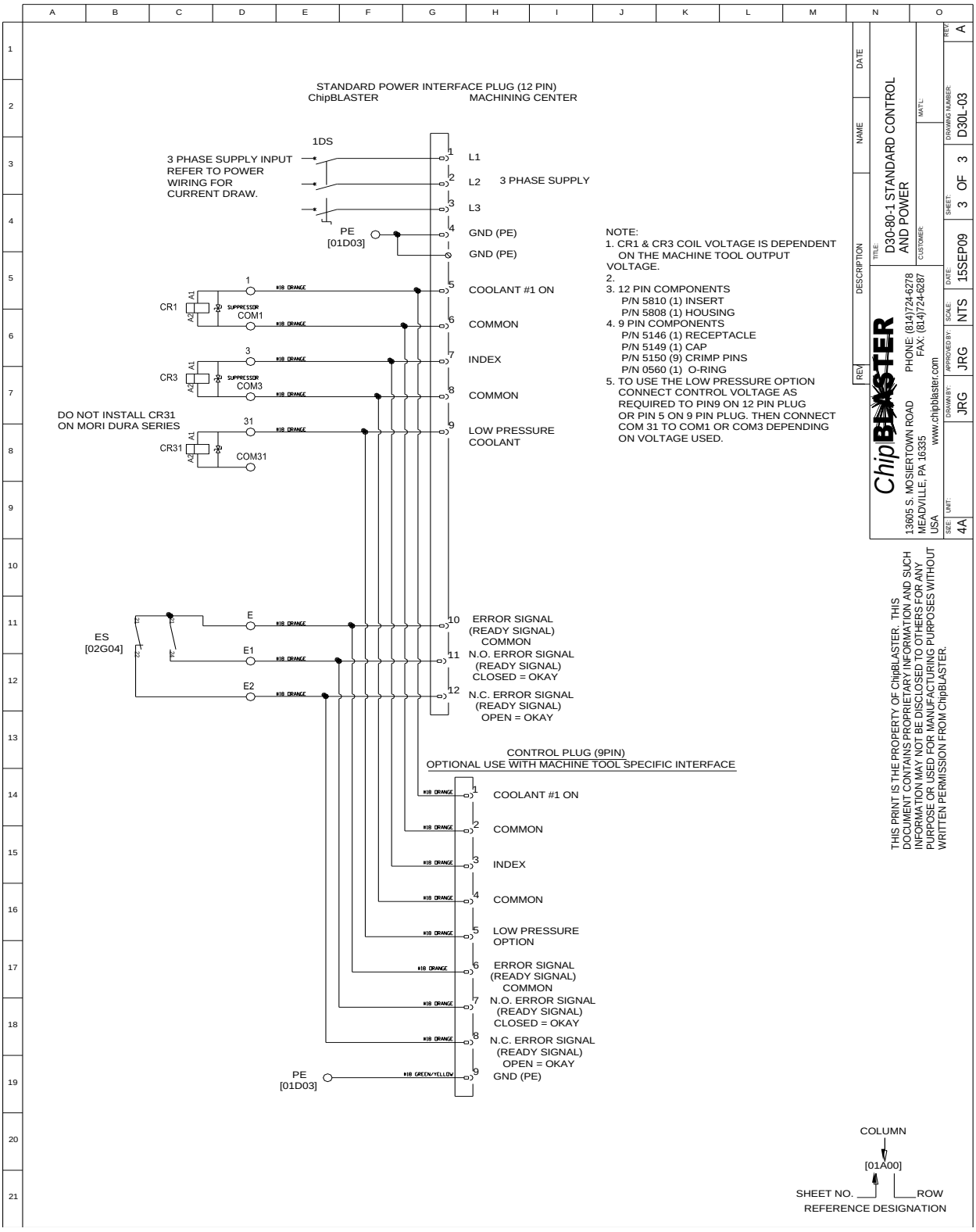
Interface Design:

ChipBLASTER systems are designed using standard plug configurations. Our standard interface cables utilize these connections on both ChipBLASTER unit and machine tool sides. We are able to also supply female connector sockets for wiring on the customer's machine tool side. In addition, we approve and supply customer specific interfaces, as required. Please refer to the illustrations provided.

JV Standard Control Wiring Diagram:



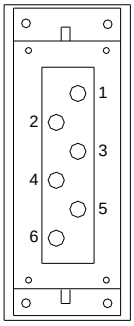
D30 Standard Power Control Wiring Diagram:

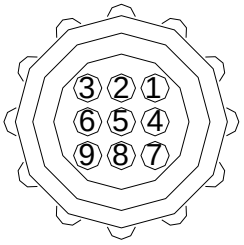


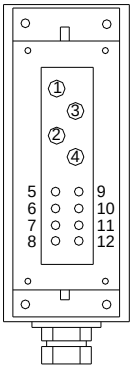
Interface Connectors:

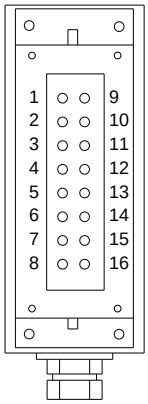
	INTERFACE CONNECTORS				
Connector Type	D30-70-1 var.	JV40/JVHP var.	EV60/EVHP var.	GV2-80/GVHP var.	WV2-120/WVHP var.
6 Pin, Harting, SIG/ PWR, Han 6E-M-s					
9 pin, size 13, Tyco/ AMP #206705-3	●				
12 Pin, Harting SIG/ PWR, Han K4/8-M	●	●	●	●	●
16 Pin, Harting, SIG/ PWR, Han 16E-M-s					
24 Pin, Harting, SIG/ PWR, Han 24E-sti-s		●	●	●	●

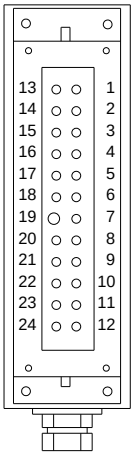
Plug Samples:











Company References

Rotek®

Manufacturer of Large Diameter Slewing Rings

Aurora, Ohio
United States

CAMERON

Manufacturer of Compressors and Valves

Houston, Texas
United States

Tanjung Pelepas
Malaysia

CURTISS WRIGHT

Manufacturer of Various Aircraft Industry Parts

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United States

Swagelok

Manufacturer of Numerous Fittings and Industrial Valves

Solon, Ohio
United States

Hong Kong
China

SKF

Manufacturer of Bearings and Seals

Hannover
Germany

St-Quentin-en-Yvelines
France

Steyr
Austria

Göteborg
Sweden

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United States	India	Malaysia

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Hamilton Sundstrand
A United Technologies Company

Manufacturers of Aircraft and Aircraft Parts

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United States

Xiamen
China

Parker

Manufacturers of Hydraulic fittings and pumps

Cleveland, Ohio
United States

Burr OAK Tool Inc.

Manufacturers of Machinery and Presses

Sturgis, Michigan
United States

MAHLE
Driven by performance

Manufacturers of Pistons and Rings

Farmington Hills, Michigan
United States

RFQ Checklist

From : (Outside Sales Name)
To : (Inside Sales Name)

Date :

Customer :
Address 1 :
Address 2 :
Address 3 :
Address 4 :

Contact Name :
Telephone No. :
Fax No. :
Email :

Destination :
Shipping Terms :

Technical Information :

Machine Tool Manufacturer :
Machine Tool Model :
Machine Tool Type :
Year Machine Tool Built :

Machine Sump : liters
Processed Material :
M-Codes : latched
pulsed

l/min. required :
kW Spindle 1 :
kW Spindle 2 :
kW add. :
Volt/Hz required :
CE required (Yes) :
70 bar capability :

Drill Diameter (mm) :
Total Tool Orifice Size (mm) :

Special Requirements / Other :

(No) :

Number Outlets :
Pressure Required (bar) :

Suggested Units :

F75		JV40		MistBLA.	
D30		GV2-80			
J20		GV3-120			
J30		EV60			
J2-60		WV2-120			
J3-90		WV3-180			

Ultra High Pressure Unit (200 bar) :

Required Options :

Tank Unit - Media Free :
Tank Unit - Chiller :
Media Free & Sludge Separator :
Dual Filters :
Dual Filters / Auto Crossover :
Quat Filters :
Oil Skimmer (single belt) :
Oil Skimmer (triple belt) :

Additional Comments :

ChipBLASTER® High Pressure/High Volume Coolant Systems

Chip BLASTER, Inc.
13605 S. Mosiertown Road
Meadville, PA 16335
USA

Telephone: 1-814-724-6278
Fax: 1-814-724-6287

Nozzle Orifice Reference Charts:

Orifice Reference Chart for 70 bar					
Orifice Dia. (mm)	Outlet Area (mm^2)	bar	Velocity (Meter/Sec.)	Volume (l/min)	Kilowatt Required
0.20	0.03	70	142	0.2	0.0
0.30	0.07	70	142	0.4	0.1
0.40	0.13	70	142	0.7	0.1
0.50	0.20	70	142	1.2	0.2
0.60	0.28	70	142	1.7	0.2
0.70	0.38	70	142	2.3	0.3
0.80	0.50	70	142	3.0	0.4
0.90	0.64	70	142	3.8	0.5
1.00	0.79	70	142	4.6	0.6
1.10	0.95	70	142	5.6	0.8
1.20	1.13	70	142	6.7	0.9
1.30	1.33	70	142	7.8	1.1
1.40	1.54	70	142	9.1	1.2
Nozzle #XX54	1.57	70	142	9.3	1.3
1.50	1.77	70	142	10.4	1.4
Nozzle #XX55	1.82	70	142	10.8	1.4
1.60	2.01	70	142	11.9	1.6
1.70	2.27	70	142	13.4	1.8
1.80	2.54	70	142	15.0	2.0
1.90	2.84	70	142	16.8	2.3
2.00	3.14	70	142	18.6	2.5
Nozzle #XX56	3.15	70	142	18.6	2.5
2.10	3.46	70	142	20.5	2.8
2.20	3.80	70	142	22.5	3.0
2.30	4.15	70	142	24.6	3.3
Nozzle #XX57	4.45	70	142	26.3	3.5
2.40	4.52	70	142	26.7	3.6
2.50	4.91	70	142	29.0	3.9
2.60	5.31	70	142	31.4	4.2
2.70	5.73	70	142	33.8	4.6
2.80	6.16	70	142	36.4	4.9
2.90	6.61	70	142	39.0	5.3
3.00	7.07	70	142	41.8	5.6
3.10	7.55	70	142	44.6	6.0
3.20	8.04	70	142	47.5	6.4
3.30	8.55	70	142	50.6	6.8

Nozzle Orifice Reference Charts:

Orifice Reference Chart for 70 bar					
Orifice Dia. (mm)	Outlet Area (mm^2)	bar	Velocity (Meter/Sec.)	Volume (l/min)	Kilowatt Required
Nozzle #XX58	8.90	70	142	52.6	7.1
3.40	9.08	70	142	53.7	7.2
3.50	9.62	70	142	56.9	7.7
3.60	10.18	70	142	60.2	8.1
3.70	10.75	70	142	63.6	8.6
3.80	11.34	70	142	67.0	9.0
3.90	11.95	70	142	70.6	9.5
4.00	12.57	70	142	74.3	10.0
4.10	13.20	70	142	78.1	10.5
4.20	13.85	70	142	81.9	11.0
4.30	14.52	70	142	85.9	11.5
4.40	15.20	70	142	89.9	12.1
4.50	15.90	70	142	94.0	12.6
4.60	16.62	70	142	98.2	13.2
4.70	17.35	70	142	102.6	13.8
4.80	18.10	70	142	107.0	14.4
4.90	18.86	70	142	111.5	15.0
5.00	19.63	70	142	116.1	15.6
5.10	20.43	70	142	120.8	16.2
5.20	21.24	70	142	125.6	16.9
5.30	22.06	70	142	130.4	17.5
5.40	22.90	70	142	135.4	18.2
5.50	23.76	70	142	140.5	18.9
5.60	24.63	70	142	145.6	19.6
5.70	25.52	70	142	150.9	20.3
5.80	26.42	70	142	156.2	21.0
5.90	27.34	70	142	161.6	21.7
6.00	28.27	70	142	167.2	22.5
6.10	29.22	70	142	172.8	23.2
6.20	30.19	70	142	178.5	24.0
6.30	31.17	70	142	184.3	24.8
6.40	32.17	70	142	190.2	25.6
6.50	33.18	70	142	196.2	26.4
6.55	33.69	70	142	199.2	26.8
6.60	34.21	70	142	202.3	27.2

Nozzle Orifice Reference Charts:

Orifice Reference Chart for 103 bar					
Orifice Dia. (mm)	Outlet Area (mm^2)	bar	Velocity (Meter/Sec.)	Volume (l/min)	Kilowatt Required
0.20	0.03	103	173	0.2	0.0
0.30	0.07	103	173	0.5	0.1
0.40	0.13	103	173	0.9	0.2
0.50	0.20	103	173	1.4	0.3
0.60	0.28	103	173	2.0	0.4
0.70	0.38	103	173	2.8	0.5
0.80	0.50	103	173	3.6	0.7
0.90	0.64	103	173	4.6	0.9
1.00	0.79	103	173	5.6	1.1
1.10	0.95	103	173	6.8	1.3
1.20	1.13	103	173	8.1	1.6
1.30	1.33	103	173	9.5	1.9
1.40	1.54	103	173	11.0	2.2
Nozzle #XX54	1.57	103	173	11.3	2.2
1.50	1.77	103	173	12.7	2.5
Nozzle #XX55	1.82	103	173	13.0	2.6
1.60	2.01	103	173	14.4	2.9
1.70	2.27	103	173	16.3	3.2
1.80	2.54	103	173	18.2	3.6
1.90	2.84	103	173	20.3	4.0
2.00	3.14	103	173	22.5	4.5
Nozzle #XX56	3.15	103	173	22.6	4.5
2.10	3.46	103	173	24.8	4.9
2.20	3.80	103	173	27.3	5.4
2.30	4.15	103	173	29.8	5.9

Nozzle Orifice Reference Charts:

Orifice Reference Chart for 103 bar					
Orifice Dia. (mm)	Outlet Area (mm^2)	bar	Velocity (Meter/Sec.)	Volume (l/min)	Kilowatt Required
Nozzle #XX57	4.45	103	173	31.9	6.3
2.40	4.52	103	173	32.4	6.4
2.50	4.91	103	173	35.2	7.0
2.60	5.31	103	173	38.1	7.5
2.70	5.73	103	173	41.1	8.1
2.80	6.16	103	173	44.2	8.7
2.90	6.61	103	173	47.4	9.4
3.00	7.07	103	173	50.7	10.0
3.10	7.55	103	173	54.1	10.7
3.20	8.04	103	173	57.7	11.4
3.30	8.55	103	173	61.3	12.1
Nozzle #XX58	8.90	103	173	63.8	12.6
3.40	9.08	103	173	65.1	12.9
3.50	9.62	103	173	69.0	13.7
3.60	10.18	103	173	73.0	14.4
3.70	10.75	103	173	77.1	15.3
3.80	11.34	103	173	81.3	16.1
3.90	11.95	103	173	85.7	17.0
4.00	12.57	103	173	90.1	17.8
4.10	13.20	103	173	94.7	18.7
4.20	13.85	103	173	99.4	19.7
4.30	14.52	103	173	104.1	20.6
4.40	15.20	103	173	109.0	21.6
4.50	15.90	103	173	114.1	22.6
4.60	16.62	103	173	119.2	23.6
4.70	17.35	103	173	124.4	24.6
4.80	18.10	103	173	129.8	25.7
4.90	18.86	103	173	135.2	26.8
5.00	19.63	103	173	140.8	27.9
5.10	20.43	103	173	146.5	29.0
5.20	21.24	103	173	152.3	30.1

Nozzle Orifice Reference Charts:

Orifice Reference Chart for 140 bar					
Orifice Dia. (mm)	Outlet Area (mm^2)	bar	Velocity (Meter/Sec.)	Volume (l/min)	Kilowatt Required
0.20	0.03	140	200	0.3	0.1
0.30	0.07	140	200	0.6	0.2
0.40	0.13	140	200	1.1	0.3
0.50	0.20	140	200	1.6	0.4
0.60	0.28	140	200	2.4	0.6
0.70	0.38	140	200	3.2	0.9
0.80	0.50	140	200	4.2	1.1
0.90	0.64	140	200	5.3	1.4
1.00	0.79	140	200	6.6	1.8
1.10	0.95	140	200	7.9	2.1
1.20	1.13	140	200	9.5	2.5
1.30	1.33	140	200	11.1	3.0
1.40	1.54	140	200	12.9	3.5
Nozzle #XX54	1.57	140	200	13.2	3.5
1.50	1.77	140	200	14.8	4.0
Nozzle #XX55	1.82	140	200	15.2	4.1
1.60	2.01	140	200	16.8	4.5
1.70	2.27	140	200	19.0	5.1
1.80	2.54	140	200	21.3	5.7
1.90	2.84	140	200	23.7	6.4
2.00	3.14	140	200	26.3	7.1
Nozzle #XX56	3.15	140	200	26.3	7.1
2.10	3.46	140	200	29.0	7.8
2.20	3.80	140	200	31.8	8.6
2.30	4.15	140	200	34.7	9.3

Nozzle Orifice Reference Charts:

Orifice Reference Chart for 140 bar					
Orifice Dia. (mm)	Outlet Area (mm^2)	bar	Velocity (Meter/Sec.)	Volume (l/min)	Kilowatt Required
Nozzle #XX57	4.45	140	200	37.2	10.0
2.40	4.52	140	200	37.8	10.2
2.50	4.91	140	200	41.0	11.0
2.60	5.31	140	200	44.4	11.9
2.70	5.73	140	200	47.9	12.9
2.80	6.16	140	200	51.5	13.9
2.90	6.61	140	200	55.2	14.9
3.00	7.07	140	200	59.1	15.9
3.10	7.55	140	200	63.1	17.0
3.20	8.04	140	200	67.2	18.1
3.30	8.55	140	200	71.5	19.2
Nozzle #XX58	8.90	140	200	74.4	20.0
3.40	9.08	140	200	75.9	20.4
3.50	9.62	140	200	80.4	21.6
3.60	10.18	140	200	85.1	22.9
3.70	10.75	140	200	89.9	24.2
3.80	11.34	140	200	94.8	25.5
3.90	11.95	140	200	99.9	26.9
4.00	12.57	140	200	105.1	28.3
4.10	13.20	140	200	110.4	29.7
4.20	13.85	140	200	115.8	31.2

Nozzle Orifice Reference Charts:

Orifice Reference Chart for 175 bar					
Orifice Dia. (mm)	Outlet Area (mm^2)	bar	Velocity (Meter/Sec.)	Volume (l/min)	Kilowatt Required
0.20	0.03	175	224	0.3	0.1
0.30	0.07	175	224	0.7	0.2
0.40	0.13	175	224	1.2	0.4
0.50	0.20	175	224	1.8	0.6
0.60	0.28	175	224	2.6	0.9
0.70	0.38	175	224	3.6	1.2
0.80	0.50	175	224	4.7	1.6
0.90	0.64	175	224	5.9	2.0
1.00	0.79	175	224	7.3	2.5
1.10	0.95	175	224	8.9	3.0
1.20	1.13	175	224	10.6	3.6
1.30	1.33	175	224	12.4	4.2
1.40	1.54	175	224	14.4	4.8
Nozzle #XX54	1.57	175	224	14.7	4.9
1.50	1.77	175	224	16.5	5.6
Nozzle #XX55	1.82	175	224	17.0	5.7
1.60	2.01	175	224	18.8	6.3
1.70	2.27	175	224	21.2	7.1
1.80	2.54	175	224	23.8	8.0
1.90	2.84	175	224	26.5	8.9
2.00	3.14	175	224	29.4	9.9

Nozzle Orifice Reference Charts:

Orifice Reference Chart for 175 bar					
Orifice Dia. (mm)	Outlet Area (mm^2)	bar	Velocity (Meter/Sec.)	Volume (l/min)	Kilowatt Required
Nozzle #XX56	3.15	175	224	29.4	9.9
2.10	3.46	175	224	32.4	10.9
2.20	3.80	175	224	35.5	12.0
2.30	4.15	175	224	38.8	13.1
Nozzle #XX57	4.45	175	224	41.6	14.0
2.40	4.52	175	224	42.3	14.2
2.50	4.91	175	224	45.9	15.4
2.60	5.31	175	224	49.6	16.7
2.70	5.73	175	224	53.5	18.0
2.80	6.16	175	224	57.6	19.4
2.90	6.61	175	224	61.7	20.8
3.00	7.07	175	224	66.1	22.2
3.10	7.55	175	224	70.6	23.7
3.20	8.04	175	224	75.2	25.3
3.30	8.55	175	224	79.9	26.9
Nozzle #XX58	8.90	175	224	83.2	28.0
3.40	9.08	175	224	84.9	28.5
3.50	9.62	175	224	89.9	30.2

Nozzle Orifice Reference Charts:

Orifice Reference Chart for 207 Bar					
Orifice Dia. (mm)	Outlet Area (mm^2)	bar	Velocity (Meter/Sec.)	Volume (l/min)	Kilowatt Required
0.20	0.03	207	245	0.3	0.1
0.30	0.07	207	245	0.7	0.3
0.40	0.13	207	245	1.3	0.5
0.50	0.20	207	245	2.0	0.8
0.60	0.28	207	245	2.9	1.1
0.70	0.38	207	245	3.9	1.6
0.80	0.50	207	245	5.1	2.0
0.90	0.64	207	245	6.5	2.6
1.00	0.79	207	245	8.0	3.2
1.10	0.95	207	245	9.7	3.8
1.20	1.13	207	245	11.5	4.6
1.30	1.33	207	245	13.5	5.4
1.40	1.54	207	245	15.6	6.2
Nozzle #XX54	1.57	207	245	16.0	6.4
1.50	1.77	207	245	18.0	7.1
Nozzle #XX55	1.82	207	245	18.5	7.4
1.60	2.01	207	245	20.4	8.1
1.70	2.27	207	245	23.1	9.2
1.80	2.54	207	245	25.9	10.3
1.90	2.84	207	245	28.8	11.5
2.00	3.14	207	245	31.9	12.7
Nozzle #XX56	3.15	207	245	32.0	12.7
2.10	3.46	207	245	35.2	14.0
2.20	3.80	207	245	38.6	15.4
2.30	4.15	207	245	42.2	16.8
Nozzle #XX57	4.45	207	245	45.2	18.0
2.40	4.52	207	245	46.0	18.3
2.50	4.91	207	245	49.9	19.9
2.60	5.31	207	245	54.0	21.5
2.70	5.73	207	245	58.2	23.2
2.80	6.16	207	245	62.6	24.9
2.90	6.61	207	245	67.1	26.7
3.00	7.07	207	245	71.9	28.6
3.10	7.55	207	245	76.7	30.5

Nozzle Orifice Reference Charts:

Orifice Reference Chart for 345 bar					
Orifice Dia. (mm)	Outlet Area (mm^2)	bar	Velocity (Meter/Sec.)	Volume (l/min)	Kilowatt Required
0.20	0.03	345	317	0.4	0.3
0.30	0.07	345	317	0.9	0.6
0.40	0.13	345	317	1.6	1.1
0.50	0.20	345	317	2.6	1.7
0.60	0.28	345	317	3.7	2.5
0.70	0.38	345	317	5.1	3.3
0.80	0.50	345	317	6.6	4.4
0.90	0.64	345	317	8.3	5.5
1.00	0.79	345	317	10.3	6.8
1.10	0.95	345	317	12.5	8.3
1.20	1.13	345	317	14.8	9.8
1.30	1.33	345	317	17.4	11.6
1.40	1.54	345	317	20.2	13.4
Nozzle #XX54	1.57	345	317	20.7	13.7
1.50	1.77	345	317	23.2	15.4
Nozzle #XX55	1.82	345	317	23.9	15.8
1.60	2.01	345	317	26.4	17.5
1.70	2.27	345	317	29.8	19.8
1.80	2.54	345	317	33.4	22.1
1.90	2.84	345	317	37.2	24.7
2.00	3.14	345	317	41.2	27.3
Nozzle #XX56	3.15	345	317	41.3	27.4
2.10	3.46	345	317	45.5	30.1