

ElfinMaster™ Advanced Fin Technology



Prospectus
presented by
Applied Cooling Technology Ltd



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'Elfin' Technology the instrument of change

The traditional methods used in the production of finned tubes and cores for heat exchangers, although in existence for several decades, still result in the same inherent design restrictions and limitations.

The introduction of new technology paves the way for the potential to improve products, redefine production costs and to address new markets, with the specific aim of increasing market share at profitable levels. These criteria were the driving force behind the development of the patented technologies of Applied Cooling Technology Ltd.

The patented 'Elfin' process imparts certain unique advantages over conventional construction methods, enabling heat exchanger manufacturers to develop new or improved products, enter new areas of business and to gain a significant competitive advantage over their rivals.

A greater choice of higher specification materials and design content coupled with environmentally-friendly precision engineering, allow all heat generating industries to benefit from new and advanced heat exchanger products. 'Elfin' technology allows the use of materials and configurations that offer:-

- durability
- efficiency
- low pressure drop

...and are resistant to:-

- high temperatures & pressures
- corrosion and erosion
- vibration and impact damage

...and are suitable for use in most heat generating industries and applications:-

- Marine
- Nuclear, Hydro-Electric and Coal Fired
- Power Generation
- Compressor
- Petro-Chemical & Offshore
- Construction and Architectural
- Rail Traction & Transportation

Whether it is to offer new alternative technologies along side existing products, to fully adopt new methods of production or to tackle new markets 'Elfin' can provide the

solution in these competitive times.

Applied Cooling Technology Ltd, a company that has had it's roots in the heat transfer industry for 3 decades, owns and licenses the 'Elfin' range of patented technologies, including 'ElfinBlock' (a multi-tube plate-fin extended surface product) and 'ElfinMaster' (the machine which is used to manufacture 'ElfinBlock').

Licenses have traditionally been sold to large organisations based on exclusive rights to manufacture both machines and products for use in specific markets and/or regions. However, due to the high costs involved in this form of licensing, we are now offering 'ElfinMaster' machinery with restricted non-exclusive licenses to a broader range of manufacturers at a much lower cost.

This shift in our marketing strategy will allow organisations of all sizes to enjoy the many inherent benefits of 'Elfin' technology.

Case Studies

more than satisfaction

Satisfied customers are always a good indication as to the integrity of a company and it's technologies.

Precision engineering with specialised plate fin enhancers reduced air-side pressure drop, without loss of thermal efficiency on marine intercoolers that contributed to a reduction of a ton of fuel oil a day on each of a fleet of 5 large, ocean-going vessels and eliminated the need for regular de-fouling downtime.

Precision built aluminium finned stainless steel tubing provided the core for a major turbo compressor manufacturer to cope with thermal duty, condensate, space restriction and automated assembly, a combination unrivalled by any other method of manufacture.

Titanium tubes with the same or dissimilar fin materials, which are inherently difficult to fin using conventional methods, perform consistently well when fins are applied the 'Elfin' way. Combined with copper fins they are the desired specification of choice for the demanding conditions found in the Power Generation and Petro-Chemical fields with life expectancies measured in decades.

Figure 1 - Fuel Cell Coolers in Stainless Steel

Figure 2 - Marine Charge Air Cooler in Brass and Copper

Figure 3 - Finned Shell & Tube Bundle in Stainless Steel

Figure 4 - Rail Traction Oil Cooler in Aluminium

Figure 4



Figure 3



Figure 2



Figure 1



ElfinBlock Technology

the result of change

'Elfin' is a Patented extended surface tube technology which utilises a cold manufacturing process to mechanically bond the fins to the tubes with great precision. This process imparts certain unique advantages over conventional construction methods, enabling the heat exchanger design engineer to "think outside the box" and gain a significant competitive advantage.

'ElfinBlock' is a derivative of the basic technology which consists of multiple plate-type fins combined with multiple tubes to form a block matrix. 'ElfinBlock' is assembled using

purpose designed and built machinery called 'ElfinMaster' - see "ElfinMaster Technology" on next page for more information.

One of the main attributes of 'ElfinBlock' is the virtually limitless choice of tube and fin materials that can be combined including copper-alloys, aluminium, stainless steel, titanium etc. See "ElfinBlock - Attributes and Benefits" below for more ways that this technology can enable the design engineer to be more creative.

There is no other product on the market today that can match the unique attributes and exceptional versatility of 'ElfinBlock' at such an affordable cost. With successes in the marine, power generation, rail, compressor and

chemical processing industries, 'Elfin' has gained an enviable reputation for quality and flexibility.

Patents and patent improvements have been applied for and/or granted in all appropriate regions including Europe, North and South America, Asia etc.

ElfinBlock - Attributes and Benefits

'ElfinBlock' is probably the best extended surface technology in the world. A bold statement indeed but how many other fin technologies can offer these benefits:-

- few limitations with regard to size and material
- fins can be pressed into different shapes and profiles
- tubes can be round or elliptical
- fins can incorporate the latest air manipulation technologies
- environmentally friendly manufacturing process
- no tube deformation (eliminates residual stress and distortion)
- tubes can be of virtually any rigid material
- fins can be made from many different materials, including aluminium, copper-alloys, titanium, stainless steel, nickel-alloys, plastics etc
- fin pitches from 1 to 40 fins per inch are possible
- fins are placed precisely and consistently
- can withstand operating temperatures of 200°C to 300°C (depending on materials)
- fins can be produced from harder material grades in order to resist impact damage and allow power washing
- integral tube/block support mechanisms can be incorporated during manufacture with minimal interruption
- tubes can incorporate an internal extended surface in order to generate turbulence or to increase the internal heat transfer surface area
- fins are mechanically bonded to tubes so no brazing, tube expanding or other secondary bonding or process is necessary

Figure 5 - Various pressed fin configurations

Figure 6 - Fins with and without airside enhancement

Figure 7 - Various 'ElfinBlock' sample configurations

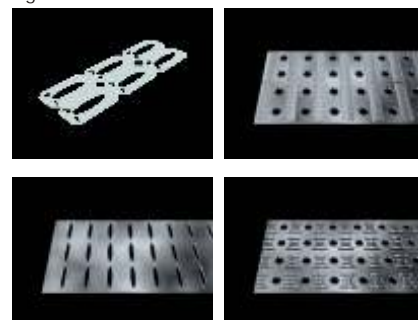
Figure 7



Figure 6



Figure 5



ElfinMaster Technology

the driving force of change

'ElfinMaster' is an electrically powered, electronically controlled "finning" machine which has been developed specifically to assemble the two components that make up 'ElfinBlock', i.e. the tubes and plate-type fins.

During the development process, several fin placement methods were considered and tested. Pneumatic power is fast but not sufficiently powerful. Hydraulic and mechanical power sources are sufficiently powerful but are too slow. The breakthrough came with the discovery of linear motor technology which is now used to force the fins over the tubes and on to their final position.

A linear motor is essentially a multi-phase alternating current (AC) electric motor that has had its stator "unrolled" so that instead of producing a torque (rotation) it produces a linear force along its length. This technology proved to offer the ideal balance of power, speed, rate of acceleration/deceleration and positional accuracy.

The linear motor is coupled with a positional encoder and controlled by a modular electronic management system that interfaces with the other relays, sensors, drive motors etc, ensuring that all components work in complete harmony. This allows connection to a PC for programming, diagnostics and monitoring.

'ElfinBlock' compares very favourably to brazed heat exchanger cores but does not require high temperature brazing ovens and is therefore more environmentally friendly; tubes and fins are not weakened or softened by the high brazing temperature; 'ElfinBlock' is more flexible with regard to material combinations, tube sizes and configurations; the necessary manufacturing equipment is less expensive to buy and operate. However, the potential buyer must be aware that the 'Elfin' manufacturing process does not include the fixing of the tube-plate and header tanks which must be joined separately (for example, using rubber grommets or other flexible seals, epoxy, roller expansion, welding, soldering or manual brazing).

ElfinMaster - Attributes and Benefits

'ElfinMaster' is a totally unique machine and has been developed and improved over the past 10 years for one task: the assembly of 'ElfinBlock' finned products:-

- the only machine in the world available for the production of 'ElfinBlock'
- high speed coupled with high power for optimum operational efficiency
- powered tube clamping system
- semi-automatic scroll-fed or magazine-fed fin feeding system
- efficient and non-toxic for environmentally friendly operation
- simple to operate and maintain



Figure 8

Figure 8 - 'ElfinMaster' LSR206

Figure 9 - CNC Control Panel



Figure 9

Production

high-tech, efficient, cost effective

There are many factors that have an effect on the time taken to manufacture 'ElfinBlock' including those of both a mechanical and human nature. The electronically-controlled mechanical aspects of the process can be calculated with some degree of accuracy but the necessary human input is more difficult and variable. Some of the human elements that must be considered in the calculation of production times are:-

- The machine set up time (including the fitting of tube clamps, tube supports, pusher plate and programming the control panel)

- Fitting "bullets" to tubes

- Installing the tubes into the tube clamps

- The removal of the finished block from the machine

The automated finning time is very dependable and consistent and can be calculated based on the fin pitch and the length of the tubes. Elements that can affect the mechanical aspects of the process include:-

- The shape of the tubes and fins

- The tube and fin materials

- The straightness of the tubes and fins

- The quality and tolerances of the tubes and fins

- The ability to use lubricants where necessary

For example, a block of 650mm wide, with around 10 tubes of 500mm finned length and fins at a density of 14 fins per inch will take approximately 16 minutes to assemble from start to finish on the machine (see Labour Estimation Formula).

Using the same calculations, a similar block at 2000mm finned length would take around 62 minutes in total (excluding press time and tooling setup times etc).

The semi-automated nature of the 'ElfinMaster' finning machine allows an operator to feed and monitor more than one machine at a time. Depending on the configuration and complexity of the components being assembled, one operator could manage up to 4 different machines simultaneously.



Labour Estimation Formula

Based on Fin Pitch of 1.82mm, a Motor Speed of 2000mm/sec, a Feed Dwell Time of 2 seconds and a Block Change Time of 5 minutes:-

Mean Travel Length = Finned Length + 250mm (Example = 750mm)

Mean Travel Time = (Mean Travel Length / Motor Speed) + Feed Dwell Time (Example = 2.375 seconds)

Number of Fins per Block = Finned Length / Fin Pitch (Example = 275 fins)

Time Per Block = (Number of Fins per Block x Mean Travel Time) + Block Change Time (Example = 15.9 minutes)

Figure 10



Figure 11



Figure 10 - 'ElfinBlock' with integral tube supports

Figure 11 - 'ElfinMaster' machine with light-beam safety barriers and 'ElfinBlock' in Copper and Brass

Manufacturing quality, our constant mission

'ElfinBlock' consists of individual fins which are forced onto the tubes with great precision using the 'ElfinMaster' finning machine. The fins have tube holes formed with collars (using a separate power press) that are an interference fit with the tube, the resultant mechanical bond negating the need for any further bonding method such as bullet-expansion or brazing.

This manufacturing process allows almost every aspect of the 'ElfinBlock' design to be optimised for the target application and environment including shapes, sizes, materials and enhancements.

Material Quality continual enhancement

Material quality and specifications are an important consideration if the true benefits of 'Elfin' technology are to be realised. This method of manufacture supports a vast choice of materials, configurations and sizes. Technical support can assist in the initial stages to ensure the right choices are made and materials sourced from suitable suppliers.

Figure 17



Figure 16



Figure 12 - 'ElfinMaster' Fin Feeding Mechanism

Figure 13 - Process layout in workshop

Figure 14 - Press Tool in Power Press

Figure 15 - Various Press Tools

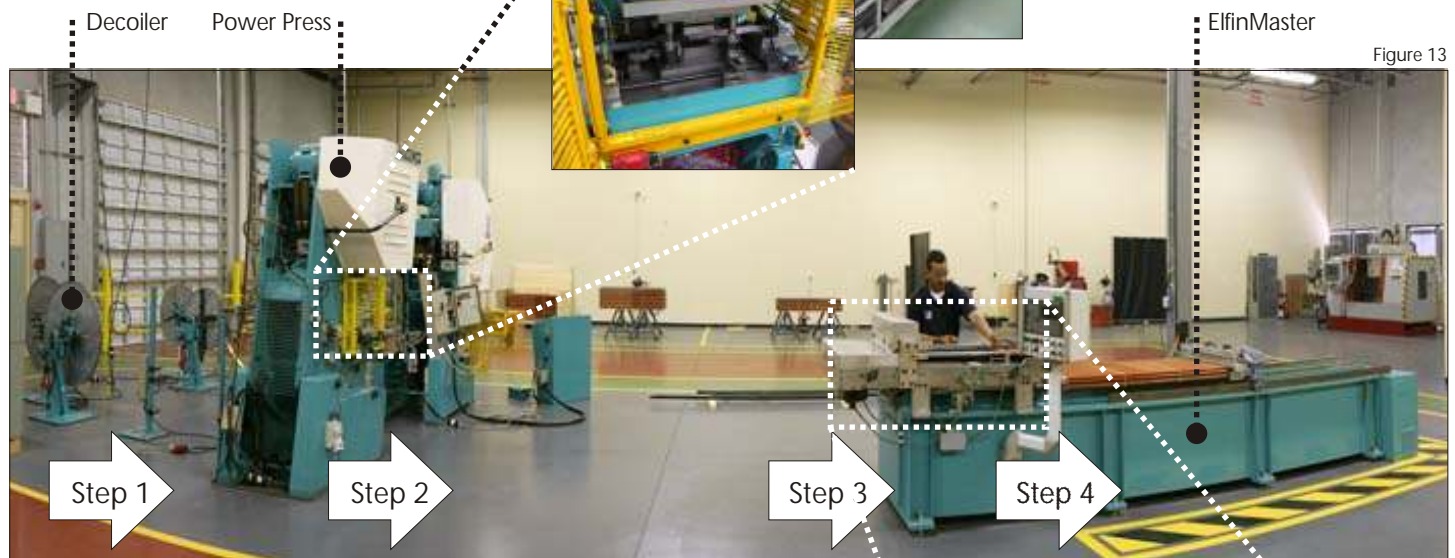
Figure 16 - 'ElfinBlock' with elliptical tubes

Figure 17 - Aluminium strip being pressed

Figure 15



Figure 14



Process

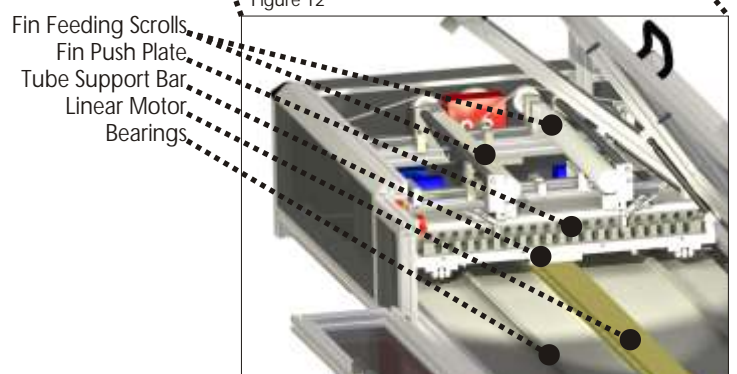
Step 1 Coil of strip is loaded onto Decoiler and then fed into Power Press.

Step 2 Fins are pressed to form the correct shape and then passed to ElfinMaster Operator.

Step 3 Tubes are loaded into Tube Clamp and Fins are loaded onto Fin Feeding Scrolls by Operator..

Step 4 Fins are fed onto Fin Push Plate and pushed onto tubes. Tube support bar automatically supports tube-ends to ensure that fins are fed smoothly. Fin Push Plate (mounted on Push Head) runs on Bearings and is powered by Linear Motor.

Figure 12



Package Proposal

to meet your specific needs

Training and Support

sharing our knowledge

A standard 'ElfinMaster' package includes the unique equipment required to manufacture 'ElfinBlock', including:-

- 'ElfinMaster' fining machine (Model LSR206)
- one set of tooling (tube clamp set, bullets, push plate and tube support)
- one twin-stage press tool for a single row fin
- one operating manual
- one maintenance manual
- limited technical support for six months*
- three day training course at our works in the UK**

* Includes unlimited e-mail technical and product support with maximum 24-hour response time (during normal UK working days) and limited telephone technical support.

** Training only, i.e. excludes attendance costs such as travel, accommodation etc.

Optional Items

for a complete solution

The purchaser may optionally specify tooling upgrades or purchase upgraded equipment at extra cost, such as:-

- 'ElfinMaster' machine upgrades for example, PC link, feeding/stacking system upgrade
- press tooling upgrade for example, you may require multiple tube rows, additional press tool stages or tool customisation
- pneumatic fin feeder
- guillotine with single or double cut action
- twelve month limited or unlimited technical support upgrade
- on-site training at your factory

A three day training course at Applied Cooling Technology Ltd in the UK or USA for up to three people is included (excluding travel, accommodation, meals etc). Your representatives will be given hands-on instruction in the set-up, operation and maintenance of the 'ElfinMaster' machine and associated equipment. Trainees should be English speaking and familiar with general CNC machine and power press operation in order to gain full advantage of the course.

Optionally, our representative can visit your factory to provide more specific/optimised training and assist with the commissioning of the machine, with a local translator where necessary. The buyer will be responsible for all associated additional costs such as flights, accommodation, translation etc.

Once the 'ElfinMaster' machine has been commissioned, we will provide up to eight hours of telephone technical support during the first six months in addition to unlimited e-mail technical and product support. Additional support can then be purchased on an hourly or annual basis.

Applied Cooling Technology offers a thermal design service on a sub-contract basis using in-house design resources. Our team of engineers can be called upon to prepare heat exchanger designs or proposals with their time being charged on an hourly basis for work undertaken.

Figure 20



Figure 19



Figure 18



Figure 21

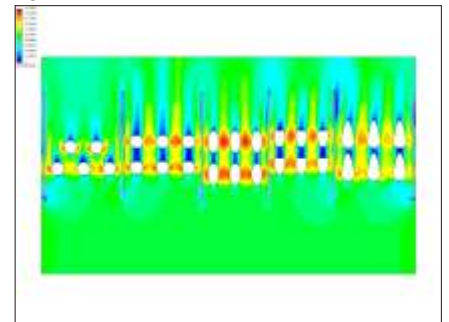


Figure 18 - Double-cut strip guillotine

Figure 19 - Electric strip decoiler

Figure 20 - Press tool (bottom half)

Figure 21 - Computational Fluid Dynamics image

Machine Specification

Model: LSR206

Machine Dimensions: 3470mm Long x 961mm Wide x 1620mm High
Approx weight: 1200 Kg

Finning Mechanical Specifications:

Max block size: 2000mm Long x 670mm Wide x 65mm Deep
Max tube aperture (pattern area): 670mm wide x 55mm high
Max tubes/rows: dependant on configuration
Max motor speed: 2.5m/sec
Max pushing force: 2.6kN peak

Electrical Specifications:

Supply voltages available:
415v 3 phase 50Hz (Europe/UK)
240v 50Hz single phase
208v 3 phase 60Hz
480v 3 phase 60Hz on request
Max current draw: 30 amps peak.

Process Requirements

your contribution

The purchaser/operator must also provide or have access to:-

electrical power supply (3-phase)
compressed air supply
power press (minimum 10 tonne with >120 stokes per minute)***
mechanical or electronic strip de-coiler for power press***
pneumatic fin feeder for power press ***
guillotine with single or double cut action for power press ***

*** These items can be supplied by Applied Cooling Technology Ltd at extra cost if required (see Optional Items).

Space Requirement

clean and compact

The machine and ancillary equipment layout is important to the efficient working of the machine in the least amount of space available. Figure 22 below shows the dimensions of the LSR206 'ElfinMaster' machine but there must also be sufficient space for operator access around the machine, plus space for ancillary equipment such as a power press and decoiler etc. Additional space is also required for tooling and the storage of raw materials and finished goods.

The 'ElfinMaster' machine must be located on a flat and level surface that is suitable for the weight and working action.

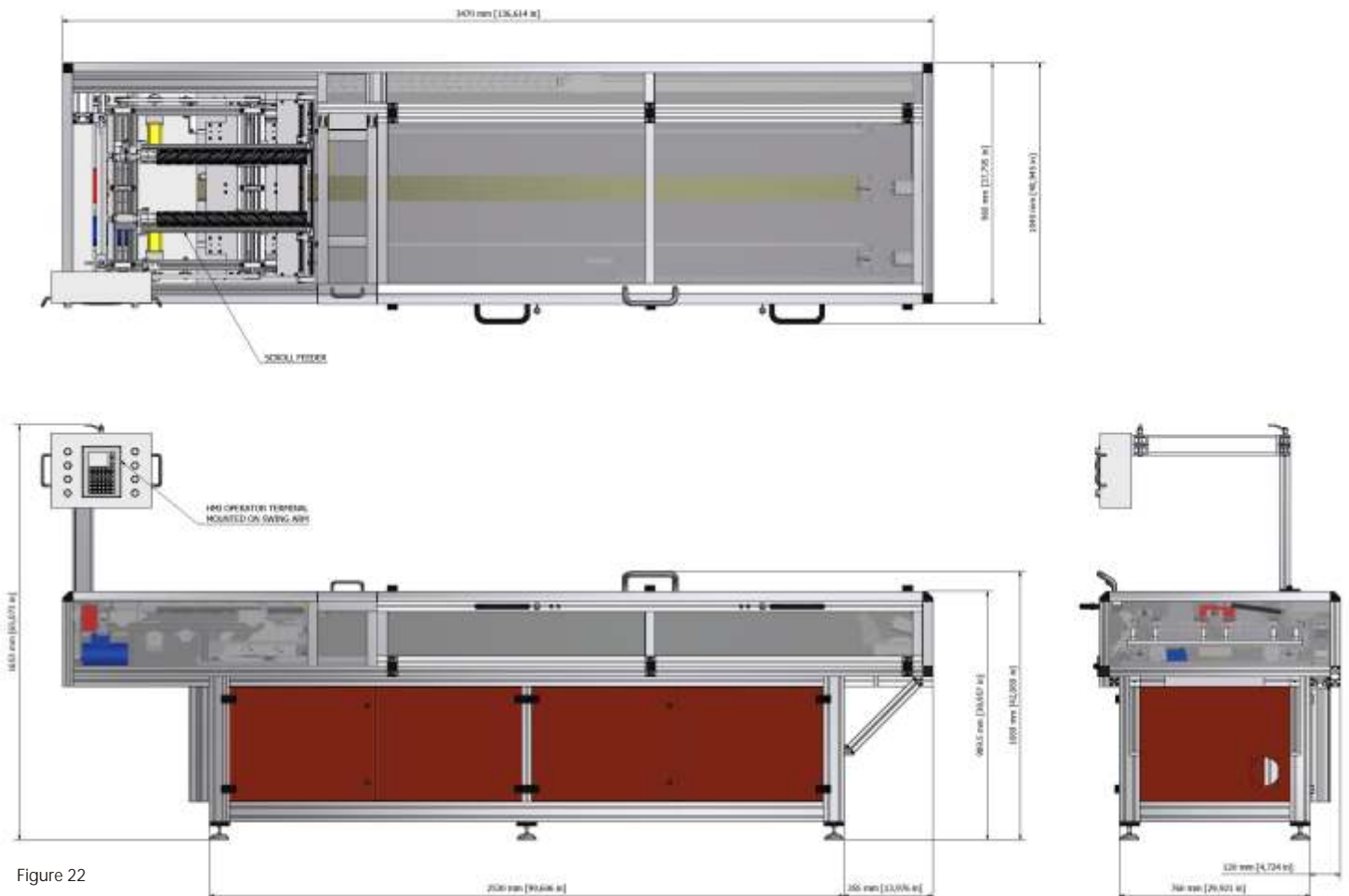


Figure 22

Pricing and Availability

affordability for profitability

'ElfinMaster' packages are available from as little as £100,000 (around US\$200,000) for a basic package capable of producing 'ElfinBlock' core up to 2000mm long x 670mm wide.

Once we have received a deposit payment and a signed contract/license agreement, despatch will usually take place within two months (subject to availability of ancillary equipment and final specification of machine tooling set). Please contact us for current lead times.

Your first press tool is included in the package price. However, an allowance to the value of such a tool can be put towards the cost of a specific tool to meet the purchaser's specific requirements. Additional press tools can be purchased as and when required, generally costing from around £5,000 (US\$10,000).

For example, the included tool, valued at £5,000 (around US\$10,000), is a twin-stage press tool producing a single-row fin and does not include enhancers on the fin such as louvers or crack and raise, nor additional rows of tubes. Should a more advanced tool be required in lieu of the included basic tool, such as a two-row tool costing £8,000 (around US\$16,000), the allowance can be used to offset some of the increased cost so the purchaser only pays an additional £3,000

(around US\$6,000).

The lead time for tool manufacture is four to eight weeks depending on the complexity of the tool. Alternatively, of course, you may already have the capability to make (or have made) your own tools locally and we will be happy to assist in this regard.

To reduce the number of tools required by the purchaser, Applied Cooling Technology offers a pressing service on a sub-contract basis using in-house tooling (see separate tooling list). Materials can be included or supplied on a free issue basis. This is a cost effective and efficient method of sourcing components for one off or small batch production runs.

All prices and delivery times will be quoted ex works.

Licensed Rights

flexible rights for changeable markets

Each 'ElfinMaster' machine purchased includes a multi-region licence to use the patented technology and design copyright incorporated within it. The machine may not be copied, duplicated or modified without the express written consent of the Licensor. The purchaser must also abide by certain requirements to maintain design confidentiality.

The machine may be used to produce finned cores for almost any industry and application, but the purchaser must agree not to make or

supply 'ElfinBlock' for use in the following industries and/or applications:-

- Motor sport or high performance automotive applications
- Aerospace applications
- Military applications
- Compressor cooling applications using stainless steel or aluminium fins on stainless steel tubes.

The above industries/applications are licensed by other clients on an exclusive basis.

Any material breach of the restrictions, covenants and license conditions will result in the license to operate the machine being temporarily or permanently withdrawn.

Next Steps

to obtain a competitive advantage

After reading this document along with a current price list, please ask us any questions that you may have. Prospective clients may also wish to visit our UK or USA factories in order to see 'ElfinMaster' in action.

Once you have confirmed in writing your intention to purchase one or more 'ElfinMaster' machines, you will receive an Order Acknowledgement which will include payment terms and shipping dates etc.





For further information, please contact:-

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