



HTI Cybernetics, Inc.

MECHANICAL DESIGN SPECIFICATIONS

The following HTI requirements will be followed in its entirety unless written authorization from an HTI representative is acquired. The design source is responsible for securing and adhering to all customers' specifications, and to address any specifications that conflict with the requirements listed below.

SCHEDULING

Weekly progress reports will be required from the design source. These reports may be formatted to the design sources choice, but must be approved prior to initiating. Content of the report should parallel the design deliverables and should list each individual fixture unit and its related progress. Progress categories as a minimum should include landmark levels such as sketch, layout, detail, and check and the related start dates, completion dates and approval dates. In addition, provide the date of shipment to HTI for build.

The design source will be responsible for achieving the delivery dates established and agreed upon. Scheduling is based upon a standard 55 hour work week. Any additional overtime labor costs required to achieve the established delivery dates, will not constitute a cost to HTI. Exceptions to this will include product or process revisions and/or additions to the design as requested by an HTI representative.

PROJECT MANAGEMENT

A single point of contact shall be designated for the design phase of the project. All data from either the customer or an HTI representative will be channeled through this one individual.

PRODUCT DOCUMENTATION

The design source is expected to keep and maintain a filing system of all product drawings, CAD data and related documents. All customer correspondence and drawings are to be date stamped when received at the design source or logged into the computer with a date ledger. Obsolete drawings will be marked as such near the title block and saved for the establishing a historical file. All obsolete product drawings, CAD files, and related documents will be filed and saved until final buy-off of the equipment at the customer's facility or when disposal is authorized by an HTI representative.

DESIGN RELEASES

Designs will be released to the HTI project manager after completion of the detailing and checking process. NO DRAWINGS are to be released to HTI for build unless the concept and layout design approvals have been performed by the HTI Design Manager and/or Project Manager. The standard HTI concept approval and layout approval forms are to be filled out by the design source prior to the scheduled meeting time.

Any units released to HTI for build without approval, may be changed or revised at no cost to HTI.

All design releases must be sent to the HTI Project Manager in triplicate if the plot size EXCEEDS an 11" x 17" format and must be accompanied by the design sources shipper. Only a single copy of the design release is required for all documents 11" x 17" or smaller.

Final "As Built" designs w/CAD files will be sent to HTI just prior to shipment of the equipment to the customer. HTI reserves the right to withhold 10% of payment from the design source to ensure delivery of "AS BUILT" drawings.

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DESIGN DEVELOPMENT

Upon award of a new project, the design source will be required to prove out the proposed assembly process outlined in the original HTI proposal documents. This process validation is to take place immediately upon the award of the project. This process should be considered as an opportunity for the design source to streamline the assembly process.

All unit designs will require a rough, but thorough sketch defining its mechanics and functionality prior to finalizing and detailing the design. The sketch should show enough information to prove out its feasibility and clearly define its content. HTI will review sketches on a weekly basis or as deemed necessary by the HTI Project Manager or Engineering Manager.

Designs must be developed with an emphasis on cost in manufacturing. Designs must be robust but with consideration for ease of machining and assembly.

All cylinders and mechanical drives will be designed with a MINIMUM of a 50% safety factor. Cylinder requirements will be based upon accurate weight calculations, cycle time requirements, and related center of gravity. Force vector calculations must be rough calculated for all pivot mechanisms that require cylinder actuation. Cylinder sizing sheets from the cylinder manufacturer are required for all applications

All commercial mechanical components must be sized in accordance with the 50% safety factor rule. Slide calculations must take into account not only gross payloads, but moment loads, rotation loads, and coefficients of friction.

Carry-over designs are preferred where possible. This results in a cost savings for both the design source and HTI. Possible C/O designs should be developed first and attempts made to integrate them into the design of adjacent units. Common fixture components such as rough locators, P/P proximity switches, primary locators and clamps should be grouped together and combined with these C/O units where possible.

Construction balls will not be allowed to define the assembly or in the machining of details. Utilize .250" construction holes located near the origination of the angle. Do not place construction holes in a lower plate of a weldment unless the angled machining is within a reasonable distance.

All designs will be in a metric format unless otherwise required by the customer. Material dimensions will be in English with the overall length in metric. Exceptions are allowed for English components that require English set-up dimensions and fasteners.

DESIGN CHANGES AND COSTS

All design changes that incur a cost must be approved by a HTI representative prior to initiating. Approval is defined as a written estimate and description with a signature of the HTI representative. Design content is based upon the original HTI proposal submitted to the design source for quoting. This will be used as the baseline for equipment content. Only equipment not covered in this base line, or product/process related revisions will be considered. HTI will not be responsible for the design errors or poor design practices. Design approval by a HTI representative signifies a working concept and does not reflect design integrity and functionality. Design approval and sign-off does not relieve the design source for the responsibility in developing a functional design that meets or exceeds the customer's requirements.

Design improvements that result in reduced costs to HTI in the assembly or build phase of the equipment, are strongly encouraged. The design source is expected to present any cost savings ideas that enhance the system without subtracting from the quality or functionality of the machine. However, any additional design costs must be approved before initiating.

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DESIGN LOGS

The design source will be required to create and maintain fixture and/or unit design logs. These logs will include critical information related to product changes, customer input and scheduled meetings. Copies of the logs will be made available to HTI representatives upon request.

DESIGN APPROVALS

Unless dictated by the customer, all designs will require approval at (2) different levels of the development process. These include:

Concept Approval (Approval to proceed with layout)

- Design fully defined
- All clearances to periphery equipment shown (i.e.. Weld guns, adj. tools, ect...)

Layout Approval (Approval to proceed with detailing, check, and shipment for build)

- All components of the design shown including cord sets, flow controls, ect...
- B.O.M. listing all commercial component information
- Cycle times verified for fixture and overall system

After 50% layout approval, the design source is authorized to complete the unit design in it's entirety and ship the drawings to HTI for build. No further design reviews will be required after the 50% level unless major changes or alterations were required to the design.

HTI will possess the liberty to make any changes at no cost to designs that have not followed the approval process.

DESIGN CHECKING

All designs are expected to be thoroughly checked prior to final release and shipment for build. Check prints must be saved and filed until final buy off of the equipment at the customer's facility. Design errors found during the build process will be communicated to the design source for updating of the drawings, at no cost to HTI.

HTI understands that no designs are error free and expect some minor problems during the manufacturing and build of the components. However, HTI will not accept gross and negligent design errors that result in excessive cost for repair. Costly repairs may be taken into account and discussed during final change negotiations with the design source.

LAYOUT AND B.O.M. SHEET FORMAT

All designs will be on HTI title block formatted sheet unless the customer unless another format is dictated by the customer. A CAD file for the HTI standard layout sheet with title block will be provided. If a customer's standard layout format is required, the HTI's company name and job number will be listed along the lower RH border of the sheets. All designs unless otherwise agreed upon by the HTI representative will be formatted to an 11" x 17" sheet with 8 1/2" x 11" B.O.M.'s. HTI will provide their standard B.O.M. format upon request.

Sheet #1A of all unit designs will be the lead sheet of the B.O.M. with each following B.O.M. page being numbered B, C, D, etc... The first B.O.M. sheet will list all layout sheets and a brief description of each sheet's content such as "Layout", "Section Views", etc... Immediately following the layout sheet designation, will be the commercial components list. Following the commercial components list, the make items will be listed.

Commercial items ordering numbers should be accompanied with the manufacturers name and component name. Make items consisting of a single sub detail should list the stock size and material. Weldments will note "Weldment" only in the material column followed by the individual sub-detail information.

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The standard HTI B.O.M. is self-explanatory, but any specific questions regarding the proper procedure for filling out the form, may be directed to the HTI Project Manager or the Engineering Manager. All layout and B.O.M. title blocks must be completed in their entirety.

The following information if applicable will be considered a minimum and will be shown on all unit layouts:

- Part information and sections as required
- ALL adjacent units to prove clearances
- ALL positions of mechanical motions in phantom
- Part load and unload clearances to fixture
- A minimum of (2) body views and an ISO view if a 3-D design
- Plan view of base
- Ballooned mm grid system with flow arrows
- Ballooned work line grid system originating at 100mm intersections
- Complete set-up dimensions on critical surfaces
- Any auxiliary views required to clearly define the design and assist in the assembly of the fixture
- Cylinder, weld gun, transformer and switch I/O designations will be of a block letter format on the layout
- Phantom outlines of pneumatic fittings and/or cords will be required where close clearances or installation problems exist
- Phantom outline of primary transformer cables and connections
- Clearly defined routing of secondary transformer/gun cables
- Phantom outline of electrical connections where close clearances or installation problems exist

Layouts will be finalized utilizing a split balloon format. Commercial components will not require a split balloon unless it is a "Commercial/Alter" item. In this case, the lower half of the balloon will designate the sheet it is detailed on. Commercial items will use an "\$" designation in the balloon and B.O.M. All make items will utilize a split balloon with the lower half designating the detail sheet number. "ND" or "Not Detailed" items will be allowed when no machining is required and the item consists of a single stock size. In this case the designation "ND" will be located in the bottom half of the balloon. Stock and material requirements for all ND items will be listed in their entirety along the balloons leader line and in the B.O.M.

Altered commercial items must be accompanied by a detail drawing which details the required modifications. It is NOT necessary to add a detail number to an "\$" number for altered commercial items.

All product data to be called out with their respective part numbers and descriptions in at least one major layout view and section where required.

A revision column will be required on sheet #1 of the unit layout. Revision notes will be required and must be maintained once the design have been released to HTI.. These releases include preliminary B.O.M's for advanced ordering. Revisions notes may be brief in nature but must clearly define the change.

Weights will be calculated for robot grippers or any other item where mass is a consideration. The total weights will be shown on the layout or where the item's properties need to be defined.

Quantities shown on the B.O.M. will include all items required to make a "SINGLE" unit. In the case of a RH/LH unit design or multiple builds, the station key sheet and master B.O.M. will accommodate additional quantities. In the case of RH/LH details being required within a single unit, the Quantity column of the B.O.M. will designate the proper RH/LH format. A check mark in the "Spare Parts" column will designate an HTI recommended component for the customer.

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DETAIL SHEET FORMAT

Each detail sheet will possess no more than a single detail drawing. All sub details must be dimensioned in their entirety and “Cut To Layout” notations will not be allowed for plate burnouts. Overall stock dimensions will be required in addition to the stock list call out.

Machining for dowels will require a “S.F.” or “P.F.” notation. Generally, P.F. dowels will accompany tapped holes, and S.F. dowels will accompany clearance holes. Exceptions to this rule will apply when certain commercial components dictate differently.

Machining dimensions will utilize an O-Line format with start dimensions in 3-planes. No single decimal dimensions will be allowed. Standard tolerances shown on the HTI drawing sheet will apply except when special fits are required.

The detail drawing must have a minimum of (2) views. Enough views must be shown to clearly define the components showing true views of all cuts and hole patterns.

Unless otherwise required by the customer, all dimensioning will be in a Metric format.

N.C. BLOCKS

All N.C. blocks will be mounted square to the vehicles grid system (i.e. F.O.L., B.O.L., and CL Body). All N.C. blocks will be mounted with standard NAAMS L-blocks where feasible. The amount of N.C. adjustment planes will be dependant on the critical locator feature. Only N.C. blocks that possess contact surfaces parallel to the body planes, can possess only a single Shim/grind spacer package. All other N./C. blocks will require a minimum of (2) adjustment planes. Each adjustment plane will possess a NAAMS standard 5mm grind spacer and a standard NAAMS 5mm shim package.

Units that mount N.C. blocks will be doweled at every joint from the base surface up to the N.C. block.

Design source should attempt to keep N.C. blocks 25mm square and as short in height as possible. N.C. detail drawings will show a thorough representation of the part section and complete set-up dimensions of the block for the machining source.

FINAL DRAWING DELIVERABLES

Design source will be required to supply HTI with (1) set of complete “AS BUILT” reproducible drawings and all related CAD files. As built is defined as the status of the equipment upon buy-off on HTI’s floor including revisions required due to design errors, improvements, and customer changes. This set of reproducible drawings, are to be available just prior to tear down and shipment of equipment from HTI’s floor.

HTI reserves the right to withhold 10% of payment from the design source to ensure delivery of “AS BUILT” drawings.

DESIGN CHANGES

All design changes, regardless of how minor, must be documented if HTI has previously received drawings on the effected area. Each effected sheet will require a HTI standard revision column. All design changes must be approved by a HTI representative prior to shipment. Three sets of prints on ONLY the effected sheets will be required when releasing the changes. Change notes must be clearly worded and be accompanied by ¼" dia. change

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balloons near the effected item. Large drawings should also include an identical change balloon under the sheet border directly below the item balloon.

FIXTURE BASES AND FLOOR PLATES

The design source is to utilize standard NAAMS fixture bases where possible. When a standard NAAMS base is not feasible, the fixture base design should parallel the construction of a NAAMS base.

The fixture base hole patterns are to consist of a standard 12mm tapped hole pattern set in a 100mm grid pattern where possible. Dowel holes are to be 12mm diameter P.F.

The NAAMS “Standard Base Leveling Method #2” is preferred for all base anchoring applications.

Unless otherwise specified by the customer, robot floor plates will consist of a single 1 ½” thick steel plate with one side “Finish To Clean-Up”. This plate will possess the robot mounting hole pattern and a ¾-10 N.C tapped hole in each corner of the plate. The ¾-10 N.C tapped hole will be used for rough leveling prior to welding the anchors to the side of the robot floor plate. The NAAMS Leveling Method #6 for Standard Robot Mounting will be used.

Operator access to the working side of the base must be considered when establishing the location of the mounting feet and floor plates. The operator will not be allowed to reach more than 16” in the loading or unloading of the fixture. The operators reach must not be restricted by the location of base floor plates.

WELD GUN UNIT DESIGN

Weld gun designs will be provided by the gun manufacturer. The design source will be required to provide a rough sketch to the manufacturer for gun selection or select an existing design from the catalogue. Gun sketches supplied to the gun manufacturer will include the following info as a minimum:

- Location of primary cable
- Basic outline of gun in closed position
- Partial outline of gun in open position
- Clearance lines caused by indexing or dump motions
- Part section through weld spot
- Metal thickness, material and coatings
- Any adjacent clearances that may effect gun selection
- Direction of gravity/floor
- Phantom outline of fixture mounting bracket
- Gun mounting bracket hole pattern and set-up dimensions to the weld spot

Transguns are preferred in most applications. Utilization of a remote transformer requires HTI approval.

All weld guns must possess an open position switch which should come standard from the gun manufacturer. All guns that possess a back-up cylinder must have a secondary switch to sense the mid position of the gun stroke. The gun manufacturer will be required to provide this secondary switch and its required mounting brackets and trip dogs.

Two directional weld gun adjustments will be required for all applications. This can be achieved through the use of 10mm gun shims and slots. The gun does not require adjustment in the direction of tip force. Gun dumps and index unit stops/shims should not be used for initial gun set-ups. All slotted gun mounts will possess weld washers or weld plates and will include adjustment jack screws to assist in set-up.

Weld guns should have enough stroke to accommodate 3/8” of tip wear per cap.

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All weld guns must be designed to weld normal to metal within +/- 3 degrees.

Projection weld gun units should utilize standard, commercial transgun units complete with a standard lower electrode package. Combination air/spring pin electrodes are preferred. Consideration for nut sensing and cylinder stroke must be made and will be determined by the customer. As a minimum, a stroke sensor such as a proximity switch will be used for the gun closed position. Gun open switches are also required to prevent damage to nut placement heads or when an automatic sequence requires a signal. Generally, Linear Voltage Transducers are preferred for a higher level of nut placement sensing. Centerline "Smart Electrodes" will not be used unless required by the customer.

INSTALLATION DRAWINGS

Installation drawings and all related sheets will be drawn in ACAD-12, 2-D format. Enough detail will be shown as to clearly define the assembly cell allowing for ease of set-up on HTI's floor.

The HTI project manager will determine what style or manufacturer of the fencing that will be utilized. HTI will also design and build all electrical panel brackets unless otherwise requested.

SHEET #1 - SYSTEMS LAYOUT - Include the following as a minimum requirement

- Master B.O.M. listing all fixtures and quantities, and peripheral mechanical equipment not included on fixture key sheet & B.O.M. (i.e. fencing, gates, fence posts, ect..)
- Plant columns, isle-ways, floor drains, and any other plant specific features in the assembly cells area.
- Accurate fixture outlines and floor plates w/operation set-up dimensions
- Outline of parts in process with body line orientation
- Operators
- Elevation views as deemed necessary to clear define the system layout
- Plant utility drop locations, and sizes w/air-water-electrical requirements
- Robots, floor plates, mounting plates
- Robot grippers
- Robot reach envelopes and orbiting run-away outlines
- Safety light screens with Minimum Safe Distance Calculation
- Based upon American National Standard For Industrial And Robot Systems – Safety Requirements
- ANSI/RIA R15.06-1999 Sect. #10.4.3 and related figures and charts as outlined)
- Perimeter safety fencing and gates
- Operator palm buttons or run buttons
- All control panels including weld controllers, master control panels, panel views, robot controllers, and main I/O panels
- All periphery equipment such as feeders and conveyors
- Stock material dunnage bins

SHEET #1A – SYSTEM CYCLE TIME STUDY

For multiple station or multiple operation assembly cells, the design source will be required to develop a complete cycle time study. The cycle time study must be computer generated using HTI's ACAD lisp program or an equivalent program agreed upon prior to the start of design. This study can summarize the individual station or operation cycle times as a block time, but must include all detailed operator functions and robot sequences. This study should be rough developed and proven to achieve cycle time at the concept level of mechanical design. A final cycle time study will be required with shipment of the system layout.

The system cycle time study must be submitted with the station cycle time/RWD studies for a controls line-up to be considered complete.

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SHEET #2 - FLOOR PLATE LAYOUT - Include the following as a minimum requirement

- Outline of all fixture floor plates
- Floor plate chart with letter designation, detail number and overall sizes
- Plant columns and aisle ways
- System O-lines and floor plate set up dimensions

Note: On simple assembly cells, the floor plate information may be incorporated into sheet #1 if all information can be clearly communicated.

SHEET #3 - CABLE TRAY LAYOUT - Include the following as a minimum requirement

- Phantom outline of system shown on sheet #1
- Complete cable tray layout showing individual components and mounting hardware
- Cable tray material stock list

Note: On simple assembly cells, the cable tray information may be incorporated into sheet #1 if all information can be clearly communicated.

SHEET #4 - MASTER WELD STUDY - Include the following as a minimum requirement

- Three views of complete assembly with body line coordinate system
- Principal Locating Points and dimensional set-ups
- All weld spots and respective numbering system
- Weld chart showing the following information
 - Operation/fixture number
 - Parts being welded
 - Metal specifications and type of weld
 - Weld spot number designation
 - Weld force required

FIXTURE KEY SHEETS

Sheet #1 General Layout

All unitized fixtures will include a key sheet showing all units and their respective base mounting pad and set-up dimension. Generally, only a plan view and/or an isometric view will be required unless an elevation view is needed to clarify the drawing. The key sheet will include a master B.O.M. which will list unit quantities and any miscellaneous related details such as the fixture base and base tapping plates. Adjacent equipment must be shown in phantom including conveyors and robots. Robot grippers that enter the station must also be shown in phantom. Each item or unit listed on the master B.O.M. will require a call-out on the layout listing the unit number and unit description.

Sheet #1A - Sequence of operation and cycle time study

A computer generated cycle time study and RWD (Request for Wiring Diagram) will be required for each individual station or fixture. The HTI ACAD Lisp program will be made available for use and is very user friendly and simple to use. The design source may use their own RWD format with approval from the design manager or the project manager. The chart will be completed in its entirety and will include function description, cylinder number, cylinder bore and stroke, switch and valve designations, and cycle time. The chart will be accompanied by a diagram reflecting all controlled mechanisms, and an outline and part number of the component parts being processed in the station or operation. Every switch and sensor shown on the RWD diagram, will require a complete ordering number for HTI's controls department to reference from.

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ROBOT KEY SHEETS

Each robot will be considered a separate tool and will include a key sheet, sheet #1A, and master B.O.M. as outlined for fixture tools. The key sheet will show the robot end effector as a separate unit. Adjacent tooling related to the robots function will be shown in phantom. This sheet will be considered as the robot reach study and must show all axis motion limits and angular dimensions for remaining envelopes.

This drawing will also include robot floor plate, mounting plates, and any required fixture tie plates. The robot layout will consist of minimum of (2) complete views for robot prove-out. Any base limits or secondary axis limits not supplied by the customer will need to be shown in detail with related mechanical components listed on the master B.O.M. This also includes gantry style robots with custom operator safety zone switches and cam tracks.

GENERAL MACHINE DESIGN REQUIREMENTS

Standard NAAMS components are preferred wherever applicable.

All designs must be robust in structure with an emphasis made on rib placement and the overall strength of the construction.

Switch brackets are not to be designed with less than 1/4" thick steel.

All slides will be protected by commercial covers if exposed during any weld cycle of the fixture. These covers must be ordered on the units B.O.M. and should be of the fire retardant type material.

Cylinders will include protective bellows if extended during any weld cycle of the fixture. The designer must be aware that the use of rod bellows require an extended cylinder rod and must be taken into account when ordering.

Cylinders are preferred if no more than 1/8" of "Stroke to go" is present in the switches sensor position. If the cylinder is subjected to possible adjustment and the 1/8" may be exceeded, cylinders may not be used. In all other cases, remote 18 mm tubular proximity switches will be used for stroke sensors.

All stroke sensors are to be mounted in such a manner that over travel of the stroke will not damage the sensor.

All large parts will be sensed in station by (2) 30 mm tubular proximity switches. Smaller parts may be sensed by a single switch. Do not edge sense sheet metal components. Do not use proximity switches for part sensing less than 18.0 mm dia. unless written authorization is acquired from a HTI representative.

All linear slides will include a commercial rod coupling to compensate for any misalignments.

Any cylinder that drives a large load will not be allowed to bottom out at either end of the stroke. The internal cylinder cushion may be used instead of remote stop blocks, only in the non-working, retracted position and with minimal loads. All working positions of a cylinder will require the use of shimmed, hardened stops with enough remaining stroke to accept the addition or deletion of a full shim package without bottoming out.

Shock absorbers with stop collars will be used for large loads whose index length exceeds 2".

All commercial components that require sizing calculations will require the manufacturer's approval before incorporating into the design. The design source is to maintain the manufacturers sizing sheets and submit a copy to HTI with the final release of the designs.

All N.C. blocks and locating pin details are to be designed with a 5mm grind spacer and a 5mm shim package. The 5mm grind spacer will be adjusted during the N.C. block certification process with the 5mm shim package being maintained at 5mm. The grind spacer will be tack welded to the adjacent L-block upon final certification of the tool. Do not order separate shims components but order the standard NAAMS 5mm shim "Package".

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All N.C. blocks and mating clamp blocks within 2” of the outside edge of a weld gun electrode, will be manufactured out of Non-Magnetic Stainless Steel. Insulation will be required only if the locator is directly inside the gun loop area creating impedance.

PREFERRED COMPONENTS LISTS

The design source will be required to acquire the customers preferred components list before starting the design. If the customer does not possess a standard list or the list is incomplete, the design source is responsible to create a list containing the components they would like to use in the design. This list must be approved by HTI and the customer prior to design.

HTI STANDARD PAYMENT TERMS – Mechanical Design

Unless otherwise agreed upon or negotiated with HTI’s purchasing department, and documented on the HTI purchase order, the following payment terms will apply for all mechanical design projects.

90% - 60 Days net from release of all build drawings

10% - 60 Days net from customer buy-off on HTI’s floor.

The release of build drawings is defined as all deliverables being checked and released for final build including all key sheets, system layout sheets, RWD’s, ect... This 90% payment is also contingent upon the drawings being updated to any changes made during the build phase of the project. Partial invoicing of separate stations or individual tools will not be allowed unless agreed upon with HTI’s purchasing department and is documented on the purchase order. The 90% payment will include all additions or changes to the original P.O. that have been negotiated with purchase orders being received by the design source.

The final 10% payment is also contingent upon the drawings being updated to any additional changes made to the tool since the last key release of drawings. The final 10% invoice will not be recognized until a complete set of electronic files of “As Built” drawings are received by HTI.