PERKINS MACHINE CO.

OUR FUTURE IS OUT OF THIS WORLD

PROCEDURES MANUAL

UNCONTROLLED COPY

"Serving the Aerospace Industry Since 1942"

TABLE OF CONTENTS

POLICY

The Purpose of this Standard Operations Manual is to outline the requirements, and set a base for the establishment and maintenance of Inspection Procedures by Perkins Machine Company Inc. This manual will assure that all products and material are inspected to the same high standards on a consistent basis. Also, this manual will serve as notice to our customers and to inform them of the methods we utilize for our various inspection processes. A copy of this manual can be made available to our customers on request.

The Quality Control Manager is assigned the responsibility of establishing Inspection Procedures and is authorized to develop appropriate documentation necessary to satisfy such requirements. From this manual, personnel will be trained to perform the duties and responsibilities assigned to them. A record of their training and qualifications will be made a permanent part of their individual personnel file.

These Inspection Procedures are designed, and based upon, the inspection requirements of MIL-STD 45662 and MIL-I-45208A for the inspection and tests necessary to substantiate article conformance to drawings, specifications and contract/purchase order requirements. This plan is based upon consideration of the technical and manufacturing aspect of production and related design and material characteristics.

Quality Control maintains written procedures of instructions to control identification of articles through out all phases of manufacturing, inspection and storage. Also, to insure that the housekeeping and handling practices prevent damage, loss, substitution and quality degradation an impartial individual appointed by the management, as necessary, will assure compliance by conducting audits.

The manual will be amended as necessary and reviewed annually to assure a continued upgrading of our Quality Control Process to conform to all customer requirements.

Supplementary Quality Control instructions shall be issued as required to clarify these procedures in specific instances.

This policy is to be followed at all times. Any questions, or doubt, concerning this policy should be directed to the Quality Control Manager and/or a Company Officer.

By: ______________________________
Robert Boulette, C.E.O./Dir. of Q.C.

Section I **Production Process**

1.) **Purpose:** To establish a basic order for the production process of the standard items manufactured by PMC. This will cover the standard off the shelf items that that we produce. This includes, but is not limited to, MS, NAS and various other standard nuts, such as drilled and plain hex nuts, and various types and styles of spanner nuts.

1.) Hex nuts: Order of manufacturing process:

a.) Material (Hex material when available)
b.) Blanking (Producing a slug with ends shaped to print and a center hole for the threading process)
c.) Thread Chamfers (Placing the correct size and angle, on the nut bore of each end, to allow for a clean threading process)
d.) Milling of Hex Flats (When no hex is available, the blank is made from round material then machined to the proper size)
e.) Sanding of Hex Flats (This removes any excess burrs from the surface of the flats)
f.) Wire Hole Drilling (When drilling corner holes the general practice is do the drilling prior to the heat treating process)
g.) Slot Milling (When slots are required, they can be processed either prior to or after the heat treating process, as well as before or after the threading process)
h.) Heat Treating (When required the parts are heat treated and then burnished or deburred as necessary)
i.) Part Marking (If the items get stamped, this is usually done prior to the parts being threaded)
j.) Threading (Threads are usually processed by outside vendors and verified by our thread plug gages)
k.) Magnetic Inspection (Magnetic inspection is processed on steel nuts to check for cracks or other indications)
l.) Penetrant Inspection (Penetrant inspection is processed on stainless steel to check for cracks or other impurities)
m.) Plating/Cleaning (Almost every part needs to be plated, passivated, cleaned or some other process to secure the outside surface of the parts)

Section I con't.

Section I, 2

2.) **Spanner nuts:** Order of manufacturing process:

a.) Material (As required by the print or customer's PO)
b.) Blanking (Producing a slug with ends shaped to print with a center hole for the threading process)
c.) Thread Chamfers (Placing the correct size and angle, on the nut bore of each end, to allow for a clean threading process)
d.) Slot Milling (When OD slots are required, they are usually processed prior to the parts being heat treated)
e.) Heat Treating (When required the parts are heat treated and then burnished or deburred as necessary)
f.) Part Marking (If the items get stamped, this is usually done prior to the parts being threaded)
g.) Threading (Threads are usually processed by outside vendors and verified by our thread plug gages)
h.) Magnetic Inspection (Magnetic inspection is processed on steel nuts to check for cracks or other indications)
i.) Penetrant Inspection (Penetrant inspection is processed on stainless steel to check for cracks or other impurities)
j.) Plating/Cleaning (Almost every part needs to be plated, passivated, cleaned or some other process to secure the outside surface of the parts)

Section II **Basic Measurements**

1.) **Purpose:** To establish a set of methods for measuring the basic dimensions that are involved within the various production cycles. This section will refer to the measurements usual found on typical hex nuts, spanner type nuts and all other types of nuts/fasteners where these types of measurements apply.

2.) **Typical Processing Measurements:** These measurements are those usually found during the manufacturing of the various nut products produced by PMC.

A.) Hex: The hex size as required by a drawing is the width across the flat surfaces of the part or the wrench flats. The width across the flats shall be the distance, measured perpendicular to the axis of the nut, between two opposite wrenching flats.

1.) **Calipers:** Utilizing the jaws of the calipers and placing them over the surface of two opposite flats and then compressed against the flats using the thumb roll. At this point the measurement is taken.

2.) **Micrometers:** Outside micrometers are used by positioning the anvils above two opposite flats, then tightening the anvils against the flats until the friction knob ratchets or slips. The measurement is taken while the anvils are secure against the hex flats.

B.) **Outside Diameter (Round Nuts):** The outside diameter of a round nut is the largest measurement available. This dimension can be a small section of material between any interruptions to the outside diameter surface, or it can be the complete outside surface of the part.

1.) **Calipers:** Utilizing the jaws of the calipers and placing them over the outermost surface of the outside diameter and then compressing them against the round edge of the OD using the thumb roll to tighten. At this point the measurement is taken.

2.) **Micrometers:** Outside micrometers are used in the same manor by positioning the anvils above two opposite points on the outside diameter, then tightening the anvils against these points until the adjusting knob ratchets or slips. The measurement is taken while the anvils are secure against the hex flats.

Section II **Basic Measurements Con't.**

C.) Part Thickness: The standard measurement is taken at the thickest point on a part at a ninety-degree angle to the hex flats or outside diameter. This particular measurement is sometimes referred to as the part height or length.

1.) **Calipers:** Utilizing the jaws of the calipers and placing them on the flat outer surface at the thickest point, at a ninety-degree angle to the thread bore, then compressing them against the two opposite surfaces using the thumb roll to tighten. At this point the measurement is taken.

2.) **Micrometers:** Outside micrometers are used in the same manor by positioning the anvils at two opposite points on the flat thickness surface, then tightening the anvils against these points until the adjusting knob ratchets or slips. The measurement is taken while the anvils are secure against the hex flats.

D.) Outside Diameter Chamfers: Most of the items we produce, both hex nuts and round spanner type nuts, have an angle or chamfer on at least one end. These chamfers are measured for both the diameter of the smaller surface of the angle and for the degree of angle from the nut face to the outside diameter.

1.) **Quick References:** For reference only the degree of angle can be determined with the use of a protractor. The protractor stem is placed against the nut surface and the degree wheel is then positioned to match the machined angle of the part being checked, then the reading is taken from the protractor face.

2.) **Optical Comparator:** Under most circumstances the use of an optical comparator would seem to be the most accurate method to confirm the angle and diameter.

E.) Washer Face: This surface is generally the bottom face of the part, or surface of the part that makes contact when the part is placed into use. There are two different dimensions concerning the machining of this surface and each one is measured separately.

1.) **Washer face outside diameter:**

Section II **Basic Measurements Con't.**

A.) **Calipers:** Utilizing the jaws of the calipers and placing them on the flat of outer surface and then compressing them against the two opposite surfaces using the thumb roll to tighten. At this point the measurement is taken.

B.) **Micrometers:** Outside micrometers are used in the same manor by placing them on the flat of outer surface and then tightening the anvils against these points until the friction knob ratchets or slips. At this point the measurement is taken.

2.) **Washer face height:** This surface is measured from the part face to where the machined diameter ends. This is usually accomplished with the use of calipers. The shank, or the long end, of the caliper is placed against the flat face of the part so that the depth rod of the instrument can slide down the outside of the turned surface. The thumb roll is then utilized to extend the measuring shaft along the OD surface until it reaches the end of the turned portion. With the caliper in place it is at this point that the measurement is taken. Also, in some circumstances the use of an optical comparator would seem to be an accurate method to confirm these dimensions.

F.) Thread Bore: The threading process is discussed at length in Sections VI & VII. This segment is only to discuss the thread bore as related to the basic measurement.

1.) **Bore Diameter:** The bore inside diameter measurement is usually checked during the initial process by the use of calipers. Use of the caliper measurement in most cases is an acceptable method for checking this dimension. However, when the item print calls for a closer tolerance level it may be necessary to utilize internal micrometers or pin gages. This dimension is checked several times from the first process to the threading process being sure that nothing has changed. Prior to being threaded the internal corner of the bore is machined with an angle according to the print.

Section III **Blanking Process**

1.) **Purpose:** To establish, and explain, the various methods utilized for the start of the manufacturing process. This first step is called Blanking…it begins with a piece of material and is machined to start the forming of the part. The material used for the making of most items we produce starts as hex or round bars and are approximately 12 feet in length. Some whole bars of material are put into our equipment and the individual blanks are machined and moved to the next process. Other material, usually 2-1/2" diameter and larger, is first cut into individual size pieces called "slugs", and then is blanked in a different type of machine.

2.) **Blanking from bar material:** Both hex and round bar materials are machined in the same manor. The choice of equipment utilized depends on size and type of material to be processed. Usually, round bar up to 2-3/8" round diameter and hex bar up to 2" hex is machined in our bar feed equipment.

A.) Prior to machinery setup the production supervisor, to comply with the dimensions on the print, verifies the dimensions on the Job Routing sheet.

B.) The job is then setup and just prior to the start of production the first parts produced are checked, verified by the production supervisor and noted on the back of the Job Card.

C.) As the parts are processed, and it becomes necessary to change any of the tooling, the production supervisor will verify each change. Then, the first few pieces will be checked and verify that they are still in compliance with the print.

3.) **Blanking from slugged material:** Machining from blanks is usually processed from round material. The bar material, usually from 2-1/2" to 5" round or larger is generally cut into slugs before blanking. The slugs are generally saw cut to be approximately .125 thicker than the actual thickness of the finished part. This allows us to cleanly machine all surfaces of the parts to the proper dimensions.

A.) After the bar material has been cut to the correct size and the slugs delivered to us they are ready to start the blanking process. Our slugs are processed in a CNC turning station, one side at a time.

Section III **Blanking Process**

These machines are setup only by our production supervisor. Once the machine is operational, and the supervisor verifies the first parts, an operator is then brought in to process the run of parts. This first stage of blanking will complete one surface of the parts.

B.) The next portion of the blanking process will be accomplished in another machine like the first one. With this machine, like the first process, is setup only by our production supervisor. Once the machine is operational, and the supervisor verifies the first parts, again an operator is then brought in to process the run of parts. This will complete the blanking process and after the production supervisor accepts the parts they will be moved to the next process location.

C.) During the slug blanking process the production supervisor checks on the machine operator on a regular bases and checks the parts to insure compliance.

Section IV **Milling Process**

1.) **Purpose:** To establish, and explain, the various methods utilized for the different types of milling required for the manufacture of the many designs we produce. The mill work we do is generally preformed on two basic types of machinery, either a vertical mill or a horizontal mill. Our use of these mills is generally to mill a hex on a part, mill slots thru the part into the thread, mill slots on the outside diameter of round nuts or to make various cuts of different sizes and shapes on the parts as required. This section will attempt to discuss all of these different operations.

2.) **Milling Hex Flats:** Milling of a hex on a part is usually to make a round nut blank into a hex nut blank. This is accomplished by utilizing either type of milling machine. In either case, an expandable mandrel is machined to hold the part by the thread bore or the part is held via a three-jaw chuck. These mandrels, or chucks, are then attached onto an index head that holds them containing the part so that it can be indexed, or rotated, keeping the parts concentric to allow for the even machining of the flats. A mill cut is produced and this process is repeated until all of the required flats are created. This process is repeated on all parts until the run is complete and can be accomplished on both types of machinery.

A.) Checking of this process is usually accomplished with the use of micrometers or calipers. Either instrument is utilized in the same manner, placing the flat measuring surface of the device so that it contacts two opposite sides of the newly milled item. Then, compressing the instrument firmly against the flat and taking the measurement reading and verifying its compliance with the required dimension

B.) The setup and monitoring of this process will be under the care of the Section Forman and/or the Production Manager.

3.) **Milling Outside Diameter Slots:** This type of milling is generally utilized to make uniform slots on the exterior of a part as a means for the installer to be able to use a spanner wrench to apply the part into operation. Using an end mill in a vertical mill usually performs this type of milling as well as the use of a round slitting saw in the horizontal mill that will also produce the same result. This will leave the outside of the item, round with equally spaced slots, or grooves, running parallel to the centerline of the part.

A.) This process leaves two major dimension to be verified, the slot width and the distance from the bottom of one slot to the bottom of the slot that is directly opposite of it. The slot width is usually measured with the internal ears located on of the top of the calipers. The ears are placed into the slot and extended open to engage the two sides of the slot. Holding firmly in place the measurement is noted. Next we measure the slot-to-slot dimension. By placing the external measuring faces into the caliper into the slots located directly across from each we can get this dimension. Then, by rotating the slip wheel until the faces are flat and firmly against the slot bottoms, this measurement can be obtained.

B.) The setup and monitoring of this process will be under the care of the Section Forman and/or the Production Manager.

4.) **Milling Slots into one end:** This process is generally utilized for the milling of castellated or general use slotted nuts. This style of nut can be slotted either before or after being threading and/or the heat treated. Again, most styles of slotted nuts can be machined on both types of milling machines. Milled slots are flat-bottomed, full radiuses or somewhere in between. The size and shape of the slot helps to determine which machine is used for the job. After the parts are milled and threaded, or threaded, milled and retaped, the slots are usually hand deburred to remove any burrs or debris remaining in the slots.

A.) This process leaves two major dimensions to be verified, the slot width and the distance from the top of the part face to the bottom of the slot. The slot width is usually measured with the internal ears located on of the top of the calipers. The ears are placed into the slot and extended open to engage the two sides of the slot. Holding firmly in place the measurement is noted. Next we measure the slot depth from the top, or face of the part, to the bottom of the slot which is either a full radius or flat bottomed with a slot corners radius on each side of the of the bottom. This dimension can be measured several ways but is usually made utilizing the caliper measuring ears. The flat surface of a tool, or measuring block, works well in this process and is held firmly in place over the open top of the slot. Then, using the measuring ears of the caliper inserted into the slot and measuring the distance between the tool and the slot bottom. The ears are extended, using the slip wheel held firmly, and the measurement taken, recorded and verified. Corner radius are checked by using pin gages or a comparator and recorded.

Section IV **Milling Process**

B.) The setup and monitoring of this process will be under the care of the Section Forman and/or the Production Manager.

Section V **Wire Holes**

1.) Purpose: To establish a standard method of inspection to accurately determine the acceptability or rejection of parts with drilled safety wire holes.

2.) Specifications: There are currently no existing specifications, that we are aware of, that define the acceptance or rejection of wire holes. With this procedure we hope to define our system of inspection designed to assure that the wire holes provided by Perkins Machine Company Inc., or their vendors, will be functional and acceptable to all. We do acknowledge these specs for reference only: AS1043, AND10387 and the "Machinery Handbook".

3.) **Standards:** The standard method of inspecting wire holes for size is to utilize solid pin gages of the appropriate diameter. The largest pin, within tolerance limits, that can be inserted easily all the way thru the hole is generally considered by most to be acceptable as the minimum diameter for that hole. But, we have been unable to find a standard definition by which all can agree for the fit of the maximum diameter pin gages. Some say that if a pin to the next one-thousandth over the maximum diameter allowed starts into the hole that the hole is oversized. Still others say that if the oversized pin enters the hole but does not go all of the way thru that the hole is okay. We all should realize why a wire hole is designed into a part. That the real test is whether a wire of the required size can easily be inserted and tied off or pull tested to meet the actual use of the part. But, the fact still remains that the wire holes are required to meet the dimensional limits of the print. With this fact in mind we are attempting to define the methods and criteria we at PMC utilize to determine the acceptability of the items we manufacture.

4.) **Theory:** First, we have to understand the basics of a hole. The idea of placing a steel pin into a hole that is supposed to be the exact same size stretches the imagination. When a pin is to be inserted into a hole for a pressed, or forced, fit the standard allowance between the hole and pin is .0010 to .0025 (Per Machinery Handbook) and this is for a hole where the pin is being forced into the hole under pressure and will not to be removed. So, it is hard to believe that we as inspectors can hope to check the diameter of a hole by inserting a pin that is the exact size of the hole. This also does not take into consideration, the fact that the outside cylinder surface of the pin has to be at exactly a 90° angle to the centerline of the hole in order not to cause excessive drag from the pin corner on the surface of the hole. We must also consider the drilling process as well. When the small wire holes are drilled the natural tendencies of the drilling action will usually cause the drill to walk or bow by just a few thousands. This leaves the hole diameter the correct size all the way thru the hole but not in a 100% straight line. Yes we have tolerances that would allow for this. If the hole were bowed by only .001 or .002 the minimum diameter pin could possibly not be place thru the hole, but it would still be a correct sized hole.

Section V con't.

5.) **Gage Pins:** Gage pins come in a lot of sizes usually starting with the .011 diameter and continuing past the sizes normally used for wire holes. Gage pin sets come in grouped size lots such as: from .011 to .040 in one-thousandth increments. Pin tolerances usually come in either +.0001 or -.0001 from the basic pin diameter. We utilize the pin sets that are of the -.0001 tolerance. The pin gages usually have a sharp corner where the outside diameter cylinder meets the end of the pin. Where practical and possible, we grind a small radius or angle at one end of the pin. We have found that this keeps the corner or sharp edge of the pin from digging in or grabbing the inside surface of the hole that is being checked.

6.) **Conclusion:** We have determined that as long as a gage pin, of no more than .002 smaller than the minimum diameter listed on the print, will enter into the wire hole, at least partially (perhaps up to one third of the hole length), and where the maximum diameter pin allowed will not enter the hole more than half way, the wire hole is deemed to be acceptable. The hole will be large enough to accept the proper size wire and still be strong enough to withstand a pull test.

7.) **Additional Note:** There are some wire holes where the location and dimensions conflict with other aspects of the drawing. As an example of this condition we can look at the MS 21340 series nut. The location of the wire hole allows the tolerances of the wire hole and that of the thread to overlap. This in turn allows for the thread to intrude, or break into, the wire hole itself. The thread gage will enter as necessary, but the gage pin will not be accepted. If the hole is reamed first the pin gage is accepted, but the threads will not gage. Which way is correct? We take the view that the thread is foremost since the wire utilized thru the wire holes is smaller than the hole is itself.

Section VI **Threads**

1.) Purpose: To establish a standard method of inspection to accurately determine the acceptability or rejection of threaded items. Since Perkins Machine Company rarely manufactures items with external threads; that process will only be discussed briefly.

2.) **Specifications:** This procedure is designed to assure that the threads manufactured by Perkins Machine Company, or their vendors, comply as closely as possible with the following specification:

A.) FED-STD-H28
B.) MIL-S-7742
C.) MIL-S-8879
D.) ASME B1.1
E.) ASME B1.3M
F.) MIL-STD-45662

3.) **Industry Standards:** Within the manufacturing of fasteners, as with any industry, there are certain acceptable procedures and practices. The standards shown below are to be used as a guide in determining the disposition of the items that are being manufactured and inspected.

A.) **Gaging:** The acceptable standard for the inspection of an internal thread is to use the "Go" and "No Go" segments of the Thread Plug Gage. The size of the gages is defined by the high and low limits of the thread pitch diameter. The use of these thread gages as it is described in the "Machinery's Handbook" is:

a.) "GO Thread Plug Gages: GO thread plug gages must enter the full-threaded length of the product freely. The GO thread plug gage is a cumulative check of all thread elements except the minor diameter."

b.) "HI (NO GO) Thread Plug Gages: "...it is not practical to control nor limit the torque applied by operators, nor that utilized by a specific operator at various times under varying conditions...the following practice has been adopted with respect to permissible entry. Threads are acceptable when the HI thread plug gage is applied to the product internal thread: (a.) if it does not enter, or (b.) if all complete product threads can be entered, provided that a *definite* drag from contact with the product material results on or before the third turn of entry. The gage should not be forced after the drag is definite."

Section VI con't.

B.) **Lead Thread:** MIL-S-8879, Section 3.4.6.1, refers to the lead thread this way "...the entering end of internal threads may be outside the specific limits of size...". Also, as discussed in the Machinery's Handbook "The *lead* of a screw thread is the distance the nut will move forward on the screw if it is turned around one full revolution." In other words the Lead and Pitch of a single thread are equal since it takes one revolution of the nut to form a complete thread shape. If one turn of the thread curve were unrolled onto a plane surface, the lead would become a straight line forming the hypotenuse of a right triangle. In plain language, the lead is where a thread form starts from nothing and in the arc of one revolution then takes on the shape and form of the completed thread. Depending on the type of material being used in the manufacturing of the product this developing section of thread can sometimes appear rough or even sharp. Since this is part of the thread structure and not a loose or hanging obstruction it should not be considered a burr and would be acceptable providing the product gages correctly and that the lead thread does not protrude outside of the thread cavity.

4.) **Dimensions:** There are three basic dimensions to measure in the process of inspecting threads…the Major diameter, the Minor diameter and the Pitch diameter. The method of inspection, and the devices utilized, depends on the specific requirements of the item being inspected. The "Method A" or "System 21" inspection procedures are the standard by which we inspect the thread of the products we manufacture. When requested by our customers, or otherwise as necessary, we can conduct the thread inspections to comply with the "Method B" or "System 22" requirements for internal threads.

A.) **Standard inspection of internal threads:**

a.) **The Major Diameter** is to be inspected by utilizing the "GO" segment of the standard thread plug gage. The outside diameter of this segment of the thread plug gage meets the minimum measurement for the major diameter. Therefore, the acceptance of the go plug gage allows for us to determine that the minimum major diameter requirements are acceptable.

b.) **Gaging** of the thread is accomplished by using both the GO and NO GO segments of the thread plug gage. Thread conformance is determined by following the information described in the "Industry Standard" section above.

Section VI con't.

c.) **The Minor Diameter**, or Bore, of the threads is governed by the high and low parameters as required by the thread specification. The following methods of inspection are acceptable:

1.) **Solid Pin Gages:** Due to the difficulty in using pin gages, with any consistency, we utilize them mainly for reference. FED-STD-H28/6, section 4.3.3 refers this way to pins gages "Go and NOT GO plain cylindrical plug gages are required to check the minor diameter limits...of the smaller sizes...Standard measuring equipment is usually employed in lieu of plain cylindrical plug gages for minor diameters larger than 0.375 in." But as long as the minimum diameter pin can easily be inserted into the bore of the thread and the maximum diameter pin will not start in the bore the pins may be used for acceptance. However, if the minimum pin will not insert into the thread bore completely and easily, or if the maximum pin goes in part way, then a more positive method of inspection must be utilized.

2.) **Calipers:** Calipers, much like gage pins, can be a quick and easy method for checking the size of a bore. The "Ears" of the caliper are inserted into the bore and extended out with the thumb roll to firmly meet and engage the bore surface at opposite sides. Then the resulting measurement is noted. If there is any question as to the correctness of the measurement, when practical a more positive method of inspection should be utilized.

3.) **Inside Micrometers:** When practical the use of Inside Micrometers is determined to be the best and most positive method of measuring the minor diameter of internally threaded products. Whenever there is a question as to accepting or rejecting a lot of parts this method shall prevail. Measuring with the internal micrometers will be as follows: The product shall be placed with bearing surface down on a flat granite plate, the micrometer is then inserted into the bore of the thread, while holding the instrument against the plate it is activated by turning the thumb roll until it ratchets. At this point the measurement reading is taken.

Section VI con't.

B.) **In-depth or System 22 Thread Inspection:** Our detailed inspection of internal threads is accomplished with an instrument that measures the internal pitch diameter. The equipment is produced by M.T.G. Industries and utilizes a captive ball assembly to simulate the measurement of thread wires. The M.T.G. system consists of the main device fitted with one fixed position and one movable segment from which the measurements are reflected on an attached indicator that reads in tenths of thousandths. Measuring fingers are selected according to thread size and pitch.

a.) **The Major Diameter** is to be inspected by utilizing the "GO" segment of the standard thread plug gage. The outside diameter of this segment of the thread plug gage meets the minimum measurement for the major diameter. Therefore; the acceptance of the go plug gage allows for us to determine that the minimum major diameter requirements are acceptable.

c.) **The Minor Diameter**, or Bore, of the threads is governed by the high and low parameters as required by the thread specification. The following methods of inspection are acceptable:

1.) **Solid <u>Pin Gages:</u>** Due to the difficulty in using pin gages, with any consistency, we utilize them mainly for reference. FED-Std-H28/6, section 4.3.3 refers this way to pins gages "Go and NOT GO plain cylindrical plug gages are required to check the minor diameter limits...of the smaller sizes...Standard measuring equipment is usually employed in lieu of plain cylindrical plug gages for minor diameters larger than 0.375 in." But as long as the minimum diameter pin can easily be inserted into the bore of the thread and the maximum diameter pin will not start in the bore the pins may be used for acceptance. However; if the minimum pin will not insert into the thread bore completely and easily, or if the maximum pin goes in part way, then a more positive method of inspection must be utilized.

2.) **Calipers:** Calipers, much like gage pins, can be a quick and easy method for checking the size of a bore. The "Ears" of the caliper are inserted into the bore and extended out with the thumb roll to firmly meet and engage the bore surface at opposite sides. Then the resulting measurement is noted. If there is any question as to the correctness of the measurement, when practical a more positive method of inspection should be utilized.

3.) **Inside Micrometers:** When practical the use of Inside Micrometers is determined to be the best and most positive method of measuring the minor diameter of internally threaded products. Whenever there is a question as to accepting or rejecting a lot of parts this method shall prevail. Measuring with the internal micrometers will be as follows: The product shall be placed with bearing surface down on a flat granite plate, the micrometer is then inserted into the bore of the thread, while holding the instrument against the plate it is activated by turning the thumb roll until it ratchets. At this point the measurement reading is taken.

4.) **MTG Measuring:** This method utilizes the MTG brand of measuring device with extended carbide prism fingers for measuring bore diameter. There are two sets of prism fingers, one for .250 to.625 diameters and a second pair for measuring .625 and larger diameters.

Section VII Thread Squareness

1.) Purpose: To help understand the methods used to check the squareness, or perpendicularity, of the thread pitch diameter with relationship to the products bearing surface.

2.) Specifications: To the best of my knowledge there are no written procedures, or specific specification governing this process. It is not easy to accurately measure this aspect of a threaded item.

3.) Standards: The most common method of checking the relationship between the part thread and the part face is to place the nut on a threaded plug and insert the plug between two centers. The part is then rotated with an indicator adjusted against the part face and that measurement would presumably give us the desired information. We consider this process to be a good reference for this measurement, but not acceptable for rejection criteria. The problem with this method is the way that parts fit the threaded plug. Some people will use the go segment of a thread plug gage while others use the no go segment. But unless every part fits exactly the same the variables of this process govern the results.

The first consideration must be given to all of the various tolerances that come into play with this measurement. The tolerance of the pitch diameter, of a nut as an example could be .0044, plus the tolerances of the thread gage pitch diameter. These tolerances mean that some parts will fit the gage snuggly and others may fit loosely. The angle of the thread itself, both on the gage and in the part, can vary from the high to the low tolerances affecting the fit while both are still in conformance. A simplified example of this is achieved by placing a nut on the go segment of the thread gage approximately half way up the gage. Now, holding the gage firmly in one hand and gripping the nut with the other hand see if the nut moves, or wiggles, on the gage without rotating it along the gage. Any movement of the part on the gage, no matter how slight, will create an incorrect measurement because the indicator pressure against the part can cause it to move. We have also experienced a difference in the measurements of most parts that are inspected twice. The same part produces different readings with each inspection.

Also, consider what a thread plug gage checks. A thread plug gage is used to check an internal thread and determine if it is acceptable by given standards. It does not measure or verify the dimensions of the nut. It checks the minimum major diameter, verifies that the minimum pitch diameter is accepted and verifies that the maximum will not enter more than allowed.

3.) Conclusion: Common sense tells us that the best way to check the thread squareness to the part face would be to simulate the part's actual use. But this is not always practical. Other methods are available but not necessarily practical for every company to have in their

Section VII, Con't.

inspection roster. In general it is not practical for the average system to check close tolerance square ness. We would recommend that in these situations that an outside facility, with the proper equipment be utilized. In the alternative, the Johnson Gage Company and the MTG Equipment Company both make equipment that has the capability to process this type of measurement.

Section VIII Secondary Process

Policy: This section is included to best discuss and explain the secondary operations that are utilized on a daily basis to the aide in the manufacturing process. This will cover the in house procedures and processes to make the parts ready for the outside vendors that are used for processes that we do not perform. This would generally include, but is not limited to, the following actions: thread chamfering; sanding of hex flats; de-burring, by any of the various methods of manual or machine; part marking; facing of part surfaces and basic handling of all items in process. This section also covers the packaging and shipping of completed items. All processes that are discussed in this section are monitored and verified by either the area supervisor or the production manager.

1.) **Thread Chamfering:** After the parts are blanked but before they are moved to the next station, the thread bore needs to be prepared to accept the threads. To help eliminate a burr being raised, when the parts actually being threaded, the specs call for the corner where the bore meets the part face to have an angle. The angle is compatible with the shape of the thread and eliminates the forming of a raised burr on the face of the part that could interfere the operation of the parts. Smaller parts are usually held in place on a flat surface and the chamfer is made by a tool designed to form the angle to meet the requirements. Larger parts are usually held in a fixture, on the inside or outside, to make the chamfer where a tool is moved in to form the angle.

2.) **The Sanding of Hex Flats:** Regardless of whether a part is produced from hex material, or round material milled into a hex, the part needs to be sanded. The basic machining processes will leave a residual burr, or ruff edge, at the hex corner and the new surface edges. This process is normally done on a flat disc sander with an adjustable table mounted on the sander. The parts are held firmly against the table surface and pushed into the sanding disc and moved from side to side or as necessary to eliminate any burr, ruff or sharp edge to the part. This leaves a clean smooth surface that can then easily be wire hole drilled or processed in whatever manor is required next.

3.) **Part Marking:** Marking is usually done at PMC by either metal stamping or ink marking. A third process of laser marking is accomplished at one of our outside vendors that specialize in laser processing. Ink marking is done by our production staff utilizing rubber stamp holders, that hold various sizes of letters, that can be assembled to print whatever information is required including our registered manufacturers ID symbol. Metal stamping is our most common form of part marking. This is accomplished with one of our stamp presses using a type holder that contains metal letters of various sizes and logo as needed. The stamping is processed one part at a time or when practical in small batches. When the part is of the proper size and shape it is marked in a multiple step

Section VIII Secondary Process

process with our vertical milling equipment. With some items the part can be marked in the milling cycle by engraving the part marking after the milling is completed but before the part is removed.

4.) **Deburring Process:** During the various manufacturing processes it becomes necessary to perform some type of a deburring function. This could be a very simple procedure from tumbling the items to any number of hands on individual types of deburring. This notation will address the processes utilized most often:

a.) Tumbling: We utilize two basic types of bulk machine deburring, tumbling and vibratory. When using the tumbling method, the parts are placed into a polygon shaped tub along with various types of tumbling media. Then a liquid is added and the tub is rotated with the flat segments aiding in the "tumbling motion" to cause the parts to interact with the media to deburr the parts.

b.) Vibrating: The vibratory method works on the same premise, using a vibratory movement to make the parts interact with the deburring media. In either case when the process is completed and the parts have finished deburring they are removed from the equipment, separated and air-dried. Then, if necessary, the parts would be coated with a preservative solution.

c.) Sanding: The sanding is processed on either a belt sander or a disc sander. Sanding is normally necessary to smooth the flat surfaces of an item, whether it that was machined or a part of the original material like hex bar stock. Sanding removes any rough or burred material edges leaving the parts ready for the next operation.

d.) Grinding: The grind style of deburring is normally processed with a hand grinder. The most common use of this practice is to remove the burr from a milled slot after the threading is complete, or to remove the burr from the slot after the part thread is re-taped. The threading, or re-tapping process, when preformed leaves a burr in the slots, the best way to correct this is to remove the excess burr material with the hand grinder equipped with a small thin grinding wheel. This is accomplished as the operator grinds the burr from the slot using a hand held grinder and viewed through an eight power magnifying glass. After this process, the parts are reviewed and as accepted they are moved to the next operation.

Section VIII Secondary Process

5.) **Packing and Shipping:** At the completion of each process the parts are placed into metal pans and the pans are tagged with our “pink” process tags. We utilize pink colored tags because they stand out in our own facility as well as making them highly visible at all of our outside vendors. When parts leave our facility and upon their return they are inspected to make sure that they can be processed and handled limiting any damage to the parts. When the parts are completed, and approved by the QC Dept’s final inspection, they are placed in our shipping area to be processed. Depending on the size and type of part being handled, it is determined what would be the best method for packaging and the amount of parts per package. Parts with scheduled ship dates are prepackaged and placed in our shipping hold area to be shipped on the customers requested ship date. All orders are processed in accordance with the requirements and instructions of our customers purchase orders.

Section VIII **HARDNESS**

1.) Purpose: During the process of manufacturing some items it may become necessary to either determine or verify the hardness of an item. We currently have the equipment and procedures for accomplishing this task, but only to the Rockwell B or C scale. All testing will be performed by the Quality Control Department utilizing the Certified Enco Hardness Tester #95/214. Unless otherwise stated the sample size will be according to ANSI/ASQC Z1.4, Level S-2, AQL 1.5.

A.) Heat Treated Items: Products that are heat-treated are generally inspected by the heat treatment company and certified as to the hardness of the part. When required by the print or requested by the customer's purchase order our Quality Control will check the items hardness and record their results on PMC/412 the "Hardness Verification" form.

B.) Hardness Verification: Some parts may be required, either by the print or customer's purchase order, to comply with either a minimum or maximum hardness factor. A lot of the appropriate size will be selected and checked on our Rockwell hardness testing equipment. The high and low results will then be recorded on the "Hardness Verification" form PMC/412 to determine if the parts are within the acceptable range. Noncompliance could result in further processing to heat treat or anneal parts as necessary.

2.) Hardness Testing Procedure: The testing of the hardness of an individual part is processed by the use of our Enco Rockwell Tester. We can certify to two Rockwell scales; the "B" scale and the "C" scale.

A.) Rockwell "B" Scale: The "B" scale is measured by the use of the Rockwell tester equipped with the "B" scale test indentor inserted in place and the load wheel set for 100Kgs. When the indentor is changed, or removed for any reason, the indicator should be verified by the use of the B scale test plate. Placing a test sample on the adjustable tower platform is how the tester operates. The adjusting wheel of the platform is then operated to press the indentor against a solid flat surface of the sample where it is elevated until the tester dial stops movement. At that time the 100kg load is released allowing for the proper pressure to be applied to the sample. This is the time that a reading is taken from the Rockwell testing dial and recorded on the work sheet.

Section VIII **HARDNESS**

B.) Rockwell "C" Scale: The "C" scale is measured by the use of the Rockwell tester equipped with the "C" scale test indentor inserted in place and the load wheel set for 150Kgs. When the indentor is changed, or removed for any reason, the indicator should be verified by the use of the C scale test plate. Placing a test sample on the adjustable tower platform is how the tester operates. The adjusting wheel of the platform is then operated to press the indentor against a solid flat surface of the sample where it is elevated until the tester dial stops movement. At that time the 150kg load is released allowing for the proper pressure to be applied to the sample. This is the time that a reading is taken from the Rockwell testing dial and recorded on the work sheet.