KSS KEYSAFETYSYSTEMS	SPECIFICATION NUMBER 1003746	Page 1 of 36 REVISION: 2

ENGINEERING SPECIFICATION

SUBJECT:	ORIGINATED BY:
Plastics Tool Standards Manual	**Dave Dziuda: Procurement**

REVISIONS:

REV	DESCRIPTION OF CHANGE	BY	DATE	ECN NO.
1	Release	Dave Dzuida	04/07/04	83055A
2	Amended 33 : Part Identification Requirements	Michael J. Moore	12/15/06	26886

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INTRODUCTION

This manual has been prepared as a guide for specifying, purchasing and qualifying plastic molds for Key Safety Systems suppliers. All tooling shall be designed and constructed to meet or exceed the standards contained in this manual.

In addition to providing a means to distribute technical information, this manual shall supplement information contained on the purchase order and will be considered as such by the Tool Engineering Department of SRS. Furthermore, this manual should not be considered as a means of relieving the supplier from designing and constructing a quality mold. The supplier has the final responsibility for constructing a mold that will produce parts within drawing tolerances. If the subject parts cannot be made according to the approved tool design, the necessary corrections to the tool will be made at the supplier's expense. The appropriate SRS tool engineer must approve any departure from the mold standards as outlined in this manual, in writing.

All tool designs are the property of Key Safety Systems and shall not (in total or in part) be given to another company or duplicated without written approval from Key Safety Systems. All items supplied by SRS shall be considered the intellectual property of SRS and its use, design, operation and construction are to be kept confidential by the supplier.

Any changes in delivery or cost of a tool being requested by a tool supplier shall be communicated in writing immediately to the appropriate SRS tool engineer with a copy of the request being sent to the purchasing department.

Key Safety Systems reserves the right to make additions, changes or deletions as necessary upon which updated manuals will be provided to all suppliers.

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EARLY SUPPLIER INVOLVEMENT

As a part of Key Safety Systems Early Supplier Involvement (ESI) process, the supplier will be brought in to review the product design and provide tooling/-manufacturing recommendations. During this period, SRS shall clearly communicate the fit, form and functional requirements of the part to the supplier. In addition, gate locations, ejector pin locations and mating surface interfaces will be reviewed for optimum part and tooling design. For further detail, the SRS ESI document shall be referenced.

REQUEST FOR QUOTATION TO SRS SUPPLIERS

In order to properly assess and quote the required tooling, SRS shall provide as necessary, the following items to the supplier with the Request for Quotation (RFQ):

1. An engineering drawing noting the part number, part name, revision level and date of release.
2. Specified material name and percentage (by weight) of allowed regrind.
3. Definition of the texture type as well as the area to be textured.
4. The type of tooling required or recommended as well as a copy of the SRS Tool Standards Manual outlining the guidelines for mold design and construction.
5. Annual volume of the part.
6. Estimated dates for part layout, Production Part Approval Process (PPAP) submission, and Start of Production (SOP).
7. A Statement of Work (SOW) outlining the engineering program assumptions.

QUOTATION REQUIREMENTS FROM SRS SUPPLIERS

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In order to ensure clear and concise information related to the mold design and construction has been noted in the quotation to SRS, the following information is required:

1. The number of cavities in the mold(s) that will satisfy production along with the recommended press size and sprue ball diameter size.
2. The cost and timing of the following items broken out separately:
   - A. The design of the mold.
   - B. The construction of the mold(s).
   - C. The construction of any secondary tooling required producing the part.
   - D. The cost of texturing.
   - E. The qualification process per SRS engineering specifications.
   - F. The design builds and cost of gauging fixtures, if required.
3. The source for texturing to engineering texture specifications.
4. The name, title and phone number of the responsible person(s) who will be the SRS program contacts during the program.
5. A listing of any exceptions to the design or quality specifications as outlined in the SRS Tooling Standards Manual.
6. Definition on whether the mold is to run fully automatic or with operator assistance.

MOLD DESIGN AND CONSTRUCTION

Any request for information pertaining to a tool being built for Key Safety Systems SRS, regardless of origin, should be redirected to the Tool Engineering Department.

1. Design/Documentation/Drawing Requirements

All tooling, of whatever type, is to be designed and documented, by the supplier, to the point that duplicate/replacement tooling can be constructed from the documentation. Furthermore, copies of all designs shall be provided to SRS and are to be kept, by the supplier, in a place adequately protected from damage. Wherever possible, all mold and tooling components such as bolts, heaters, thermocouples, hydraulic cylinders, etc., shall be standard models and readily available. Custom components shall be avoided and only used with the appropriate SRS tool engineering approval.

All drafting is to be done to the latest prevailing design standards. It is further to be done to the SRS format standards, if available. Designs are to be available for review and approved by SRS before construction of the tooling begins. The design shall include a print reflecting all parting lines, ejector pins and gate locations for approval by SRS and the supplier.

The SRS Tool Engineer must submit a preliminary design of the mold for review before the design can be completed. The design should include the following:

A. Plan of cavity
B. Plan of core
C. Longitudinal cross sections through major areas of mold
D. Part position
E. Runner and gate location
F. Parting lines
G. Water lines
H. Part ejection
I. Hot drop

In addition, the following drawing requirements shall be observed:

(a) All mold inserts (as specified by the SRS Tool Engineer) are to be completely detailed (or CAD model available upon request).

(b) All related views shall be separated from other details when several mold components are drawn on one sheet.

(c) All designs shall have a complete Bill of Material, including standard commercial mold components.

(d) All designs shall be ballooned with split indicators containing the detail number and the sheet number that it is dimensioned on.

(e) Each sheet of a design shall contain a title block in the lower right hand corner.

(f) Symmetrically opposite mold sections shall be assigned different detail numbers (i.e. detail 10 shown, detail 11 opposite).

(g) The minimum tonnage-molding machine required shall be specified, on the drawing, to properly run the mold.

(h) The mold design shall include in the plan view, a platen layout showing the location of the recommended machine tie rods and mounting hole locations to ensure the mold will fit in the machine and can be mounted easily and safely. The side view shall show the location of the clamps so that the installation of waterlines will not interfere with clamps. The total mold weight shall also be specified.

The preliminary design consisting of a plan view and assembly view of both core and cavity must be submitted for approval before the design is detailed. Steels for all plates cannot be ordered until the preliminary design has been approved. Rough machining of pockets, squaring of plates and preliminary handling holes can be machined before design completion. Complete design approval must be obtained before final construction has commenced.

The responsible Key Safety Systems Tooling Engineer shall approve the preliminary designs with whatever corrections are required. After the preliminary design approval, the tool design shall be detailed.

Upon final completion of the mold design, the following information shall be submitted to SRS Tool Engineering for review:

Section 1: *Bill of Materials*. This is to be a listing of all materials that go into the construction of the approved design including the following:

Section 2: *The Mold Design*. The design shall be consistent with those guidelines previously mentioned.

Section 3: *Process Notes/Certification*. This is to be a description of the end use for this item. This is a mandatory section for ISO certification. Where applicable, this section shall include the appropriate certifications for safety or certifications of accuracy such as those required in the manufacturing of measurement gages.

Section 4: *Maintenance*. This is to be an actual description of the required routine maintenance or a reference to a maintenance procedure in order to assure the precision and accuracy of the item through its productive life as designed and built in the previous sections. Reference the SRS Mold Maintenance Section.

It is the Supplier's responsibility to record all changes to the tool design during the mold construction and to update the original design as required by SRS Tool Engineering.

2. **Measurement Systems and Construction Tolerances**

To comply with international standards, it is preferable that all drawings be done in metric. However, the use of English linear measurement systems is acceptable. The prevailing rule shall be the part print. If the part is in Metric, the tooling designs shall be in Metric. If the part is in English Linear, the designs shall be in English Linear. At no time shall a design be rendered where the part design is in Metric and the tooling is in English Linear or vice versa. Part drawing tolerances are manufacturing tolerances only and will only be partially used for mold construction.

3. Waterline and Cooling System Guidelines

As a basis for adequate mold cooling, the following guidelines shall be considered:

A. All water lines shall be dimensionally located on the design drawings.

B. All waters inlets and outlets must be stamped with numbers noting different zones. Example: "1-In"/"1-Out", "2-In"/"2-Out", etc.

C. All "In" and "Out" waterlines shall be located on opposite surfaces of the mold whenever possible. In addition, waterline connections on the sides of the mold are preferable to connections on the top of the mold.

D. Standard DME male quick disconnects water fittings, or SRS approved equivalent, shall be used on all water lines.

E. All water line quick disconnect fittings and related piping will be permanent parts of the tool.

F. All water fittings shall be located a minimum of 1.5 mm below the surface of the mold to prevent possible damage. Furthermore, waterline connectors shall be mounted in a counterbored hole whose diameter is sufficient to allow the easy connection and disconnection of the female connector. Each connector is to be sealed during installation with pipe thread sealing compound or Teflon tape sufficient to prevent leakage under normal operating pressures.

G. All waterlines shall be located to produce even cooling throughout the part in both the core and cavity. These locations shall ideally be determined through thermal finite element analysis. Where this analysis is determined not to be practical, waterlines shall generally be placed within three diameters of each other and no further than 2.5 diameters from the surface of the plastic part. In the event that ideal waterline locations and cooling patterns in a mold are not possible, other efforts shall be made to ensure even thermal cooling of the part to avoid creating areas in the mold that exhibit uneven heat exchange.

H. In order to achieve proper turbulent flow through the mold, the diameter of the waterline shall be sized to produce a flow such that the Reynolds Number of the flow is in excess of 10,000. Turbulent flow may be enhanced through two specific conditions. The first condition is achieved

wherein waterlines have sharp transitions in the internal circuits which produce a more turbulent flow than observed in smooth turns. The second condition is achieved with the speed of the flow. In general, turbulent flow increases with increased flow through the circuit. In addition, lengthy water circuits should be avoided as they inherently demonstrate a significant pressure drop, which may reduce the level of turbulent flow. Ideally, the waterline circuits shall be as short as possible. If, due to the geometry of the design, adequate flow cannot be achieved, booster pumps shall be considered to improve the flow speed. As a guideline for achieving proper turbulent flow, the following table is provided. It should be noted that even though this table is based on specific assumptions of initial pressure and pressure loss through the circuit, it is provided as a guide to assist in the developing adequate flow.

Waterline Diameter (Inches)	Minimum Flow Rate (Gallons/minute)
0.250	0.6
0.375	0.9
0.500	1.2
0.625	1.5
0.750	1.9
1.000	2.5

Note: For those waterline diameters not specifically listed in this table, the dimension may be extrapolated and applied to calculate the necessary flow rate.

I. The mold shall be fitted with a drain groove connecting each countersunk waterline connector hole to allow for drainage in order to direct slight leakage away from the cavity surface.

J. It is recommended, where applicable, that the mold be fitted with valves capable of being locked in a set position to thermally balance the flow. In addition, flow meters are recommended to assure the monitoring of proper flow through the cooling circuits.

K. Stainless steel or brass baffles shall be used in place of bubbles. Plastic baffles shall be avoided. In addition, baffles shall be keyed in place and held securely with a set screw and Teflon tape.

L. Teflon tape shall be used on all connectors for the mold.

M. As general practice, water lines shall not be located in the clamp slots of the mold.

4. Standard Runner Systems/Gating

A. All runner systems shall be balanced with regards to size and cavity pressure unless otherwise specified by the appropriate SRS Tool Engineer.

B. The runner system shall minimize material usage in accordance with acceptable molding practices.

C. Unless otherwise specified, the runner shall be full round in shape with one half in each side of the mold. Maximum allowable mismatch shall be 0.002 inches. The ideal diameter of the runner shall be 1.5-2.0 times the nominal wall stock. Trapezoidal shaped runners may only be used with the approval of the appropriate SRS Tool Engineer. No other runner system cross-sections shall be acceptable.

D. All runners shall provide a cold slug well for the sprue and at the end of the runner as depicted on the following page.

E. All runners shall be provided with adequate ejection for proper removal from the mold.

F. A sprue pulley shall be used to ensure removal of the sprue from the sprue bushing.

G. A standard D.M.E. sprue bushing or SRS approved equivalent shall be used.

H. With the mold in its closed position, the runner bars shall have 0.05mm separation to allow proper venting of gas.

I. Hardened runner bars shall be used in all mold construction and fabricated from AISI Type S-7 steel (hardness: Rockwell “C” 50-54).

J. The gate cross section shall be 80% of the nominal wall thickness unless otherwise specified. The gate location shall be determined to optimize cavity fill and agreed upon by both the supplier and SRS product and tool engineering prior to tool build.

5. Cores & Cavities

1. Make cores and cavities as follows:

Large cores and cavities

AISI type S-7 tool steel (Hardness: Rockwell "C" 50-54

AISI type P-20 prehardened tool steel

B. **Small cores and cavities**

AISI type S-7 tool steel (Hardness: Rockwell "C" 50-54)

Note: **the appropriate Tool must approve any material substitution**

Engineer.

2. Cores and cavities must have adequate cooling to insure optimum production capability of the mold.
3. Cores and cavities to be designed with sufficient base size and fastening to insure stability during the injection cycle.
4. Standard D.M.E. core pins, or a K.S.S. approved equivalent, are to be used whenever possible.
5. Hard chrome plating or electrolysis nickel plating of cores and cavities will be required on molds designed to run materials considered to be corrosive.
6. All cores and cavities are to be individually inserted into the mold.
7. Small standing steel and/or critical areas of the cores and cavities are to be individually inserted. (These details will require 100% detailing.)

6. Hot Runner Systems

If the mold is fitted with a hot runner system, the mold design drawing shall reflect each hot drop location and all manifold sections. In addition, the size and location of the heaters and thermocouples to the components of the system and a listing of the heaters by size, wattage and manufacturer description shall be included. This drawing shall include how the heaters and thermocouples are wired to their appropriate receptacles.

Where injection molds are heated and insulating material is incorporated into the mold design to form a thermal barrier between the mold and the platens, a second layer of thermal insulating material shall be designed into the top of the mold to minimize heat loss from the mold.

Hot runner/hot manifold molds shall have separate insulation around the heated members of the mold to minimize heat transfer to the cooled mold plates.

The manifold plate shall be slotted for easy removal of he manifold without having to remove the wiring.

7. **Part and Runner Disposal**

All parts and runner systems shall freely fall from the mold to facilitate continuous operation of mold. Any mold which, because of part design, cannot be designed to run automatically, must be reviewed and approved by SRS Tool Engineering.

8. Safety Straps/Requirements

All molds shall have two (2) CRS Safety Straps permanently mounted to their sides to prevent the mold from opening while being handled. The straps are to be mounted on each side of the mold at the parting line to the following guidelines:

(A) The thickness of the strap shall be compatible with the mold weight.

(B) The width of the strap shall be a minimum of three diameters of the clearance holes drilled to receive the two bolts that shall hold the strap in place.

(C) The strap shall be permanently affixed to the stationary half of the mold by a standard socket head cap screw and screwed into the mold base or plate leaving a minimum of .030 clearance so that the safety strap can swing freely. The screw is to be locked in place by a cone point set

screw threaded in at the parting line at a right angle to lock the socket head screw in place. The socket head cap screw shall be made non-removable by filling the head with weld.

(D) Each mold shall have sufficient handling holes drilled and tapped in size and depth to allow handling each half of the mold and each individual mold plate. Size of the handling holes shall be predicated based on the mold size and weight. The locations of these holes are to be placed with respect to the balance point of the plates or mold halves. The hole on the moveable half of the mold shall be drilled and tapped to accept a socket head cap screw that will hold the safety strap in place. A similar hole shall be drilled and tapped on the stationary half so that the strap can be rotated 90 degrees and bolted to the stationary half when the mold is in use.

(E) Each mold shall have holes drilled and tapped of sufficient size and depth to accommodate safety hoist rings. The mold shall be supplied to the molding facility with a sufficient number of safety hoist rings attached to the holes to facilitate ease in handling the mold. The rings shall be mounted in a fashion such that no other component must be removed for their installation or use. These rings must pivot and swivel to compensate for pitch, roll and sway during handling.

(F) All slides shall be equipped with a positive holding device to keep the slides in position while the mold is open.

(G) Molds with ejection elements below a slide will have positive early ejector returns to move the ejector plate to the retracted position before the slide is actuated.

(H) All positive return details shall be fully noted on the mold design drawings and indicated on the mold base.

(I) The safety straps shall be painted with bright yellow enamel paint for identification

9. Mold Base Information and Requirements

All molds are to have the following identification clearly stamped on the mold. Stamping shall be a minimum of 0.125mm deep and 12.7mm in height.

(A) The “Top” surface of the mold shall be stamped accordingly.

(B) Each plate used shall be numbered as defined by the mold drawing. Each plate shall also have the number "O" stamped on the upper top operator side corner in the position as the mold is hung in the press. All plates shall have the type of steel and hardness stamped on them.

(C) The following shall be stamped on the mold base:

a) Part name

b) Part number

c) Tool I.D. number (Optional)

d) Customer name and identification requirements ("Property of..." as specified by the SRS tool engineer)

e) Number of cavities

f) Total mold weight

g) Length of ejector stroke

h) Tool manufacturer and location

I) Tool manufacturer's I.D. number (optional)

j) Material and shrink

k) Mold shut height

(D) All mold bases and cavities shall be constructed from one of the following materials: (1) A standard DME #2 steel, (2) An AISI Type S-7 tool steel (Rockwell Hardness "C": 50-54), or (3) An AISI Type P-20 prehardened tool steel depending on the size of the tool. If an equivalent material is used, it must be approved by the appropriate Key Safety Systems Tech. SRS tool engineer.

(E) All leader pins and bushings shall be constructed with a standard DME material or a Key Safety Systems Tech. SRS approved equivalent. Furthermore, all molds shall have four (4) leader pins and bushings. The appropriate SRS tool engineer must approve any exception. If SRS approves a mold base with two (2) leader pins, one pin shall be of a different diameter.

(F) All molds shall have one (1) guide pin offset by 5.5mm to faultproof the mold from being assembled incorrectly.

(G) All molds shall provide a minimum of two (2) pry bar relief slots sufficient for opening the mold.

(H) All mold bases shall provide for tapped holes in the top and both sides of each half of the mold for handling purposes as described in the Safety Straps section of the manual.

(I) All molds designed with flat parting lines shall incorporate standard DME die locks or a Key Safety Systems approved equivalent.

(J) All plates in the mold base system, with the exception of the clamp plates, shall be cooled.

(K) The size of the mold base shall be large enough to hold the cavities, leader pins, slides and other mechanisms with additional mold base material giving sufficient strength so that the mold will not distort or the cavities shift with continued operation.

(L) The mold shut height shall be sufficient such that the mold clamps and other mechanisms do not interfere with each other during installation and operation.

(M) Wherever possible, a standard mold base and mold component shall be used in preference to a custom base and/or components.

10. Mold Preload

The cavity inserts or the core and cavity shall be preloaded to stand 0.0010 to 0.0015 inches higher than the overall parting line and extend for 0.250 to 0.500 inches. The rest of the parting line shall be cleared by 0.050 inches.

11. Standoff Pads

The height of the parting line shall be around the guide pins such that the preload will exert on the parting line but shall not be effected by the pressure from the platens. The standoff pads shall be of sufficient area to avoid crushing the preload shutoff at maximum clamp pressure.

12. Die Locks

The mold shall be fitted with die locks of sufficient size and placed in locations where shifting of the cavities will be minimized. Furthermore, wear plates, constructed of bronze alloy to minimize galling, shall be mounted on heel blocks.

13. Guide Pins, Leader Pins and Bushings

The mold shall be fitted with leader pins to obtain initial alignment during the mold-closed phase of operation. The mold shall contain a minimum of two (2) leader pins for small inserts (with SRS tool engineering approval) and a minimum of four (4) leader pins for any independent mold base. Leader pins shall be industry standard pins (i.e. DME) or an SRS approved equivalent.

All leader pins shall be mounted in the corners of the mold. One pin shall be offset or of a different size (as described in the Mold Base section of this manual) to eliminate the possibility of miss-assembly of the two mold halves. The pins shall be of sufficient diameter to allow the mold half with the pins to be placed in a manner where the mold is standing on the pins, without damage or distortion.

All leader pin bushings shall be through holes to prevent the hole from filling with material. In addition, bushings shall be constructed of self-lubricating material (such as bronze alloy) to minimize galling and excess wear on the leader pins.

As the leader pins serve a secondary function of protecting the portions of the mold above the parting line, all leader pins shall be mounted on the same half of the mold and shall be longer than the highest protrusion of the standing mold core or contoured parting line. This effort will protect the mold from damage when placed face down. Additional leader pins may be installed on the opposite side of the mold from the primary leader pins to protect any standing horn pins or contoured parting lines from damage when placed face down. In addition, leader pin bushings shall be placed in the mold half that contains the cavity.

14. Standoffs/Risers

The mold shall be fitted with standoffs, rails or similar protective mechanisms that allow the mold half or entire mold to be placed face down on any surface without damage to the external hydraulic cylinders, limit switches, sensing pins or other protrusions that extend beyond the outside of the mold base surface. They are to be placed in such a manner so that the mold or mold half will not easily tip over.

15. Springs

Springs shall be installed in the ejector plate system to assist in the return of the plate. All springs shall be pocketed and have a mechanical stop so that it cannot be over compressed. The mold is to be designed so that the spring's maximum compression is no more than 35%.

16. Slides, Lifters and Heel Blocks

The chosen material for the slides and lifters shall be AISI Type S-7 tool steel (Rockwell Hardness "C": 50-54) or AISI Type P-20 prehardened tool steel depending on the size. Alternate materials may only be used with SRS tool engineering approval.

Slides shall be positively locked in place with double wedge locks to avoid movement after the mold is closed during the mold operation. Furthermore, all slides and lifters must be equipped with a positive holding device while the mold is open.

Hardened heel blocks (drivers) will be used if possible, and constructed of the following materials:

AISI Type 06 Tool Steel (Rockwell Hardness "C": 58-60)
AISI Type 01 Tool Steel (Rockwell Hardness "C": 56-58)

All horn pin actuated slides shall be spring loaded such that the slide is held in position/ mechanically latched or both to accept the pin and not slide out of position if mounted vertically in the mold.

All slides shall be mechanically actuated. Hydraulic actuation shall be used only with SRS tool engineering approval.

17. Stop Buttons/Pry Slots

The ejector plate shall be fitted with positive stop buttons and all plates shall have pry slots to facilitate separation during maintenance. If the mold is pried open by advancing the ejector plate with pry bars, and the mold has slides that will be damaged by the premature action of the ejector plate, the mold shall be fitted with a plaque on the side of the ejector plate stating - "Damage will occur if ejectors are moved forward before mold is fully open".

The mold shall be fitted wit pry slots to facilitate opening the mold with pry bars if necessary. All plates shall have additional pry slots to allow easy separation during maintenance.

18. Wear Plates

All areas prone to wear shall have easily replaceable wear plates, hardened slides and be fitted with a lubrication system if required. Standard integral or lamina-bronze wear plates or an approved equivalent shall be used under all slides. To fabricate wear plates, the following materials and heat-treating are required:

AISI Type 01 Tool Steel (Rockwell Hardness "C": 56-58)
AISI Type 06 Tool Steel (Rockwell Hardness "C": 58-60)

In addition, AISI Type 01 (Rockwell Hardness "C": 56-58) or AISI Type 06 (Rockwell Hardness "C": 58-60) shall be used for slide gibs (keepers).

All wear plates shall conform to the following:

(a) A center key, in addition to the side gibs (keepers), is to be used to guide all slides whenever the width of the slide exceeds the length.

(b) All wear plates and gibs shall contain grease grooves.

(c) Aemite grease fittings are required to assure adequate lubrication.

(d) Large slides shall have adequate cooling to insure optimum production capability of the mold.

19. Ejector Pins

All ejector pins (hot work type) shall be nitrated or hardened and be constructed to DME standards or an SRS approved equivalent.

20. Core pins

All core pins inside sleeve ejectors shall be retained by a cap plate held in position by a minimum of two screws. Furthermore, the following criteria shall be met:

(a) The ejector plate assembly shall have standard DME stop pins or an SRS approved equivalent to ensure minimum deflection during the injection cycle.

(b) Guide pins and bushings shall be used to ensure continued alignment of the ejector assembly.

(c) Ejection shall be required under all runners.

(d) All molds shall have ejection return springs.

(e) Molds containing ejection elements below a slide shall have positive early ejector returns to move the ejector plate into the retracted position before the slide is actuated as a safety precaution.

21. Core Pin Shutoffs and Pilot Pins

All core pins that shutoff against steel or are piloted into a hole shall be through hardened material.

22. Ejector Systems (Non-Ejector Pin)

All stripper plates, rings or blades shall be case hardened or nitrated.

23. Pillar Supports/Support Rails

Rails or pillar supports shall be 0.001 inches higher than the outer housing rails supporting the ejector half of the mold.

24. Knock-Out Pads

Pads shall be installed on the ejector plate to accept the knockout rods. These pads shall be recessed 1/16 of an inch from the platen, protruding through the clamp plate to accept the knockout rods. These pads shall be threaded to accept the knockout rods and keyed into the ejector plate.

25. Vents

All ejector pins that have more than one inch of stroke shall be round circumfrencially 0.150 of an inch down from the top an amount consistent with the depth appropriate to the material. An atmospheric vent shall be ground down the length of the pin as wide and deep as possible to assure proper venting. The detail and construction of these pins shall be noted separately on the tool design drawings.

All cavities shall have full perimeter vents of a depth and land width appropriate to the material as recommended by the material supplier. These vents shall then flow to a 0.100-inch wide by 0.100-inch deep cannel. This channel shall mate with a secondary channel of approximately the same dimensions that will vent to the parting line edge and then to atmosphere.

Blind pockets or deep ribs may require passive vents or venting channels into blind areas to assure fill without burning.

26. Rough Edges

The molds outside edges shall be filed or radiuses to be free of sharp edges on all sides.

27. Hydraulic and Air Circuit Identification

(A) *Hydraulic Circuits*

Each hydraulic circuit shall have stamped on the mold surface, or an accompanying I.D. plaque, its purpose such as “Core 1” or “Core 2”. The identification is to include a notation for the side that is pressurized, its forward position (designated with the letter “F”) and return position (designated with the letter “R”) along with the maximum operating pressure to avoid damage to the mechanism.

(B) *Compressed Air Circuits*

Each compressed air circuit shall be identified as to its purpose (such as “popped blow off”) and the required pressure to assure proper action. Each circuit is to be fitted with a quick disconnect fitting and labeled “Air In”.

28. Hydraulics

Each hydraulic circuit is to be plumbed with a male connection attached to the side that is pressurized in the forward position and a female connection to the side that is pressurized with a return position. The mold is to be supplied with appropriate hoses, with mating connectors that can be attached to the machine's hydraulic manifold.

Confirmation of the movement of the hydraulic circuit shall be done with confirming electrical or fluidic sensing devices that sense and confirms the full forward and full return position of the moving member. Where core sequences are required, the core sequence is to be *described* as to their action in the mold design.

All hydraulic cylinders shall utilize a "T" fitting in preference to a threaded connection as related to the moving member it actuates.

29. Electric's

All electrical mechanisms, including but not limited to limit switches, cavity pressure sensors, hot runner circuits, motor drive circuits etc., shall be installed in accordance with prevailing electrical wiring standards by a competent licensed electrician. All circuits are to be wired with grounding connections. All circuits are to be terminated in an appropriately approved housing and adequately labeled as to power requirements. All wires are to be insulated with a material sufficient to provide appropriate electrical insulation for its proscribed application. (Example: Where the heater is a circuit, mica/fiber insulation or its equivalent will provide sufficient insulation in a high temperature environment. Insulation on limit switches for hydraulics should be oil and water-resistant.)

30. Painted Sections of the Mold Steel

The ejector box plates shall be painted bright orange. *In compliance with OSHA, any moving member on the outside surface of the mold shall be painted bright orange.*

31. Miscellaneous Construction and Design Notes

(A) **Shims**

No shims shall be used in tool construction, maintenance or repair.

(B) **Blind Pockets**

All blind pockets shall have 0.030 of an inch minimum radius on all wall intersections.

(C) **Sprue Bushing**

The sprue-bushing orifice shall be specified. The sprue bushing shall be bolted to prevent rotation with a minimum of two screws. Where required, the sprue bushing shall be keyed to assure proper alignment with the gate and runner system.

(D) **Side Action Mechanisms**

All side action mechanisms shall have positive holdbacks to avoid the mechanism from accidentally moving foreword. All side action mechanisms shall incorporate wear plates and (where allowable) grease grooves, lubrication lines and grease fittings on the outside of the mold.

32. Shrinkage

Part shrinkage shall be determined by the mold supplier and specified on the mold design. It is the responsibility of the supplier to execute the build of the mold in compliance to the shrinkage specifications of the design. Any adjustments necessary to correct the mold due to improper shrinkage are the sole responsibility of the supplier.

33. Part Identification/Recycability

All parts shall have unique identification on the cavity or core surface such that the identification is molded into the part unless common tooling is applied within the manufacturing & production of multiple component part numbers. Under these conditions of shared tooling the decision for part identification is the discretion of the product and/or tool engineer to determine for the tooling-mold . The appropriate SRS product engineer with SRS tool engineering approval shall specify the size and location of the identification. The content and format of the identification shall be as follows:

A. All parts shall have raised characters (numbers/letters) , unless otherwise specified

B. SRS product and tool engineering shall indicate on the drawing a rectangular location for identification on a non-functional surface of the part. The size of the rectangular area shall indicate the approximate size of the characters.

C. The part and cavity number shall be indicated as follows:

Example: E12345 X

Where: E12345=SRS Part Number Designation

X=Cavity Number Designation (i.e. 1,2,3...)

In the event that there is insufficient space, characters may be omitted with SRS tool and/or product engineering approval.

D. All parts shall be marked for identification and recyclability with the type of material from which the part was fabricated in accordance to the most recent issue of SAE Standard J1344 - "Marking Of Plastic Parts". This document as well as other related information may be obtained through the following organizations:

E. Parts manufactured & produced in various colours for purpose of visual , error or mistake proofing & routing may default to original part identification within tooling.

SAE (Society of Automotive Engineers)
Commonwealth Drive
Warrendale, PA 15096-0001
Phone: (412) 776-4841
Fax: (412) 776-5760

SPE (Society of Plastics Engineers)
14 Fairfield Drive
P.O. Box 0403
Brookfield, CT 06804-0403
Phone: (203) 775-0471
Fax: (203) 775-8490

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34. Mold Faultproofing

As some molds may have slides, pins, blades, sleeves or stripper rings placed in front of hydraulic mechanisms such as side cores, mold faultproofing shall be present. In the event that the mold has these mechanisms that

can inadvertently actuate the hydraulic mechanism and cause damage to other components, the mechanism shall have some confirming safety mechanism (such as a limit switch) to assure no interference or damage can occur in normal operation. Where the ejector plate cannot be used to open the mold due to pins contacting a moveable feature, a plaque shall be prominently mounted on the mold warning of the damage that will occur.

35. Cavity Finish

Unless otherwise specified, the cavity shall be polished in the line of draw to allow for maximum release of part. In addition, the core shall be polished at 90 degrees to the line of draw. All mold texture shall be specified on the SRS component part drawing.

ENGINEERING CHANGES

It is the joint responsibility of SRS and the Supplier to document and control all changes from ESI through mold completion and into production. This section shall describe the procedure for engineering changes.

Authorized Engineering changes:

All changes shall be preceded by a "Request for Quotation" (RFQ) from the appropriate SRS tool engineer detailing the exact change for quoting accuracy. Once the quote has been approved by SRS, an "Authorization to Proceed" and/or a purchase order shall be issued along with an SRS released/approved engineering drawing. Any work completed by the supplier without proper documentation as outlined above, shall be considered unauthorized and non-billable to SRS.

GAGES

It will be the joint responsibility of SRS and the supplier to identify principal locating points and datum's from which the gage is responsible to check. All gages will require gage reproducibility and repeatability (R&R) certification from a 3rd party source independent of SRS or the supplier. Any further gage requirements shall coordinated by the supplier through the SRS quality department.

PART LAYOUT/TOOLING APPROVAL

In order to qualify all tooling, the mold shall be capable of producing parts to the SRS released engineering drawing. The supplier in submitting parts for layout and final tooling approval shall observe the following procedure.

Step 1: The supplier shall select a predetermined quantity of parts at random, which are required for initial sample layout. These parts shall be from a production lot run under normal operating conditions utilizing production materials and equipment. SRS Supplier Quality shall determine the quantity per cavity and lot run size and Tool Engineering in order to ensure production representative parts. These parts, which shall not be altered by any means inconsistent with the production control plan, are to be checked dimensionally by the supplier consistent with the GD&T specified on the SRS released drawing. In addition, it shall be the supplier's responsibility to furnish all tryout material.

Step 2: **When** all dimensions on the released print are measured and recorded, a layout report including actual measurements and deviations shall be filled out by the supplier (see Reference Materials section for proper form). A circled number shall identify each dimension on the part print and this number shall correspond to the item number on the layout report. Any discrepancies observed shall be recorded as such. In order to ensure that the raw material used is representative of the quality to be received for production, a material certification must accompany the part samples. Lastly, the supplier shall submit a "Molding Data Sheet" (see Reference Forms section) outlining all molding parameters associated with the trial run.

Step 3: A completed layout report per Steps 1 and 2, a marked engineering part print and the corresponding sample parts shall be submitted to the appropriate SRS Tool Engineer. The layout will then be disposition per SRS product and tool engineering.

Step 4: Upon disposition of the report, the layout will either be approved or rejected per the following guidelines:

If the dimensional layout for each cavity is approved with no discrepancies, the tooling will be considered approved for production.Approval will be granted by obtaining a signed layout indicating acceptance of the layout. It should also be noted that the mold should demonstrate ongoing dimensional capability with respect to defined critical dimensions.

If the layout is approved with drawing changes required, the tool will be provisionally approved until the updated drawing is released. Once the updated drawing is released, a new layout shall be generated by the supplier indicating conformance to the updated dimensions. At this point, the tooling shall be considered approved for production.

In the event that the layout is rejected, the tool shall be updated, at the supplier's cost, in order to bring the necessary dimension(s) into print. Once the tooling corrections have been made, a new layout shall be submitted for re-disposition of the part.

STORAGE

All tooling-producing parts for SRS shall be held without charge at the supplier's facility on a consignment basis. Furthermore, the supplier shall store the above items in a manner such that they will not be exposed to any environment (thermal, chemical, etc.) capable of degrading the quality of the tooling.

Appropriate procedures such as the use of a rust preventive coating, storage in boxes or other protective wrapping shall be adhered to as a normal part of the storage procedure.

All SRS stored tools shall be labeled in such a manner that they are easily identifiable for removal and use as production requirements dictate.

All storage requirements shall also adhere to the requirements outlined in the mold preventative maintenance section of this manual.

TOOL TRANSFERS

Should SRS choose to remove the tool from one supplier and place production at a different supplier's facility, SRS shall provide written notification detailing the plans as such.

MOLD PREVENTATIVE MAINTENANCE

In order for SRS to ensure the quality and integrity of all parts produced, the supplier shall be responsible for maintaining and documenting a mold Preventative Maintenance Program. Furthermore, with routine maintenance, all tooling is expected to meet its quoted lifetime volumes. It is the supplier's responsibility to communicate with the appropriate SRS tool engineer the appropriate maintenance as necessary. Although not all-inclusive, the following guidelines shall be used as reference for proper mold maintenance.

The degree and frequency of maintenance are determined by many factors such as the mold material, complexity of the part and mold, part material, operating conditions, and environmental conditions.

As a general rule, a mold transferred to storage shall be maintained to ensure that it may be pulled for running qualified production parts. All molds in storage awaiting maintenance shall be quarantined to prevent running production parts prior to the necessary maintenance. When a mold is removed from production, it shall be tagged as follows: "OK For Production", "Hold For General Maintenance" or "Hold For Major Maintenance" - indicating the mold has been approved for the next production run or maintenance work is required prior to the next run. The supplier shall be responsible to develop a set of tags, work orders and an appropriate approval system in order to ensure that this procedure is followed and maintained.

If a mold is pulled from production for maintenance, it is the responsibility of the supplier to ensure that the proper paperwork is filled out to facilitate the mold repair and/or maintenance. As a part of this documentation,

it is important to note if any dimensions have been modified and thereby require that the mold be re-qualified. This maintenance shall be predicted and scheduled accordingly.

In general, any replacement of a mold component that effects a critical dimension on the part or effects any part surface under quality inspection (such as surface finish), require that the mold be re-qualified as though it were a new tool. However, SRS only requires that the area effected is re-qualified, and not the entire tool permitted that no other dimensions are effected.

For discussion purposes, the mold maintenance frequency shall be classified into four categories:

(A) Minor/Routine Maintenance
(B) Inspection Maintenance
(C) General Maintenance
(D) Major Maintenance

(A) Minor/Routine Maintenance - To be performed periodically throughout each production run and each time the mold is removed from production or as agreed upon by the appropriate SRS tool engineer.

(1) Before the mold is removed from the press it shall be heated (if the mold is chilled) so that all surface condensation is evaporated. With the mold still warm, internal mold surfaces should be gently cleaned with shop safety solvent to remove any residual dirt and grime.

(2) All water lines shall be drained and blown free of any residual water in order to avoid build-up of rust due to standing water.

(3) The mold shall be identified with a tag attached to the safety strap identifying its status per one of the following: “OK For Production”, “Hold For General Maintenance” or “Hold For Major Maintenance”.

(4) A general inspection check shall occur to ensure all bolts, plates, clamps, etc, are in place and secure.

(5) The mold shall then be stored with a part from the last run prior to maintenance as an example of the typical quality of this run.

(6) When removing a mold from storage, routine maintenance shall occur as follows. The supplier shall ensure that the mold is identified as "OK For Production" without further maintenance by verifying a signed tag showing the mold has had any required maintenance already completed and certified.

(7) The mold shall then be opened and, using proper approved safety shop solvent, the mold preservative shall be removed with a lint free pad. The supplier shall not assume that the first shorts are scraps and will therefore be used to clean out the mold preservative. By not removing the mold preservative, the mold's natural venting system may become blocked causing start-up difficulties, which are avoidable. Furthermore, parts contaminated with mold preservative that are reground may contaminate virgin material and cause additional scrap.

(B) Inspection Maintenance - To be performed each time the mold is removed from production or as agreed upon by the appropriate SRS tool engineer.

Using a checklist and visual inspection techniques, the supplier shall inspect the mold for any minor repairs that are necessary and note accordingly in their mold history log for future evaluation.

In addition to the tooling records, part of the record keeping process also involves noting the difference in process conditions on the original set-up guide, as process changes may be an indication of required tool maintenance. As a reference, several examples are noted: (1) An increase in the pressure differential from the inlet and outlet water lines may indicate that the lines are scaling or rusting shut, (2) Also, increased frequency of burned parts or burn lines may indicate blocked vents, (3) The need for multiple ejection that was not previously needed may be an indication of the need for work on the ejector system, (4) An increase in clamp pressure to keep flash controlled may be an indication of the mold hobbling itself closed requiring work on the parting line shutoff. Although these examples are only a few and serve as a general guideline to illustrate the need to note process changes, it should be noted that they might indicate the need for tool maintenance.

In addition, the following shall be referenced:

(1) Any missing components or blocked cavities shall be noted and corrected. If the cavity is blocked, a sample shall be retained for the mold maker for reference in making repairs.

(2) The mold shall be washed with safety solvent to remove the varnish and build up from the molding process.

(3) Bent, worn or broken ejector pins shall be noted. The mold shall be removed from production and the pins replaced.

(C) General Maintenance

To be performed on an as-needed basis. Each time the mold is removed from production, inspection maintenance shall be performed. During inspection maintenance, it shall be determined whether general maintenance is required. It should be noted that only competently trained technicians should perform this maintenance.

For General Maintenance, the following guidelines shall be observed:

(1) All plates shall be separated and their faces thoroughly cleaned.

(2) All moving parts and components shall be disassembled, checked for wear, cleaned, re-lubricated (if required) and re-assembled.

(3) All components shall be checked for wear. Any excessive wear shall be noted and a determination made to replace, repair or continue to use.

(4) All rough areas outside the cavity detail area shall be worked-out. Any area inside the cavity detail area with dings, dents or other signs of wears or abuse, shall be considered critical and SRS notified immediately prior to repair.

(5) Vents shall be checked for depth, width and land as compared to the tool design specifications. This data shall be recorded on a checklist and a determination made to repair if required.

(6) "O" rings seals and gaskets shall be checked for integrity and replaced if necessary.

(7) All water lines shall be pressure tested for leaks and re-certified for flow capacity. Waterlines that have built up scale and are restricted shall be pressure cleaned with a desiccating agent.

(8) The ejector system shall be examined for proper alignment. If the ejector pinholes have become distorted, the supplier shall notify SRS immediately prior to repair.

(D) Major Maintenance

Skilled tool and die personnel shall perform this maintenance only. Major maintenance shall be conducted when triggered either by the mold fulfilling the required number of cycles for maintenance as scheduled by the supplier, or when excessive wear and/or damage occurs to the tool. If major maintenance is required, the appropriate SRS tooling engineer shall be notified prior to any repair. After major maintenance repair, the appropriate SRS tool engineer shall review the tool.

Before maintenance begins, there shall be four complete shots (parts, sprues and runners) delivered with the tooling for analysis by the supplier and SRS. Two shots shall be from the initial mold qualification, which are to be labeled and retained. This provides a visual record of part acceptability when the mold was new and fully functioning. The second two shots shall be labeled as the most recent parts produced before the tool was pulled

for maintenance. A comparison of the "before" and "after" shots may give an indication of wear and abuse the tool has suffered.

A study of the parts and the supplier maintenance log shall result in a plan between SRS and the supplier for maintenance of the tool. A listing of the required repairs, the time table for completion and the work required for re-qualification of the mold shall be submitted by the supplier and approved by SRS before work commences.

(1) All components determined and authorized to be replaced shall be removed and new components constructed and installed in accordance to the original mold designs if previously certified spare components are not available.

(2) Worn leader pins, bushings and all bearing moving surfaces shall be checked for wear and replaced/repaired as required.

(3) Plates and mold cavity surfaces shall be checked for parallels and corrected if required.

(4) The mold cavity surface shall be cleaned and polished as required to the original surface requirements. Galling, dings and dents shall be corrected until the surface matches the original print specifications.

(5) All components not meeting the part print's original specifications shall be repaired, replaced and re-qualified as required.

(6) All components that have been plated should be stripped and re-plated where required. All components that have had special surface treatments for corrosion resistance, lubricity, hardness and the like, should be re-treated to insure the original intent of the tool.

(7) All moving components shall be checked for ease of movement and adjustments made as required. All return springs in the ejector plate shall be replaced with new springs to avoid fatigue.

(8) All water lines shall be flushed with descaling agent to remove any scale build up. All "O" rings, internal plugs, seals and gaskets shall be replaced.

(9) With the approval of the appropriate SRS tool engineer, cavities may be removed and stress relieved to remove work hardening and material embrittlement per the Welding and Stress Relieving Section in this manual. After stress relief, the cavity shall be re-hardened to the specified tool design hardness. The entire mold/cavity set shall be re-inspected and re-qualified as though it was a new cavity.

(10) The mold base shall be inspected for cracks, work hardening, corrosion, etc. If the mold base was plated or painted for corrosion resistance, the coating shall be stripped, the base cleaned and then the coating reapplied. The mold's ID shall be re-done indicating the tooling was re-built.

(11) The cavity surface shall be inspected for wear or erosion of plating or texturing. In the event that any damage is evident on the cavity surface, the appropriate SRS tooling engineer shall be notified immediately.

As a part of maintenance, a general guideline as follows has been provided for reference in stress relieving and welding of molds:

Reference Forms