LAYOUT STANDARDS for the **Hawkeye Model Railroad Club**

Version 2, Adopted February 21, 2007

The purpose of these layout standards is to assure that high-quality layout design and construction methods are used. The Club's goal is to be able to construct and operate a layout that works in a highly reliable and satisfying fashion.

Definitions

Secondary Track = Any trackage that is not mainline track but is outside of yards or industrial areas. For example, sidings and staging tracks are secondary tracks.

AWG = American Wire Gauge.

Shall = The use of the word "shall" in this document denotes a requirement.

May = The use of the word "may" denotes an optional choice that could be used.

Maximum Grade

Mainline = The maximum grade for a mainline shall not exceed a 1 in. rise in a run of 48 in. (2.083%).

Branchline = The maximum grade for a branchline shall not exceed a 1 in. rise in a run of 33 in. (3.03%).

Staging Leads = The maximum grade for a staging lead shall not exceed a 1 in. rise in a run of 33 in. (3.03%).

Vertical easements shall be used to avoid abrupt transitions into and out of grades. The bent stick method is an acceptable method of laying out the easement.

Industrial spurs should be constructed to be as level as possible. If cars tend to roll on a given spur, then an unobtrusive, manually operated braking or holding device shall be employed to prevent the car from moving or potentially fouling other trackage.

Yard trackage should be as level as possible. Yard ladder tracks may transition from the higher mainline level to the lower yard level.

Curves

Minimum Curve Radius

- The minimum radius for mainline track is 36 in. The use of wider-than-minimum radius curves is encouraged in highly visible areas of the layout where the layout design makes this practical.
- The minimum radius for branchline or secondary track is 30 in.
- The minimum radius for yard and industrial track is 24 in.

Horizontal easements shall be used between tangent trackage and all curves on mainline, branchline, and secondary trackage. The bent stick method, using a wooden yardstick, is an acceptable means of laying out the easement. The length of an easement is taken as 14 in. See Appendix B for how to lay out curved easements.

A maximum of 0.040 in. of super-elevation is allowed on curves. See Appendix C for how to lay out a curve with super-elevation.

The minimum tangent that shall be allowed between curves of opposite directions on mainline, branchline or secondary trackage shall be equivalent to the length of an 89-ft car. Therefore, the minimum tangent for an S curve shall be set at 14 in.

Track components

Minimum Turnout Sizes

#8 turnouts or larger shall be used on all mainline trackage, including crossovers and sidings. #6 turnouts may be used to branch off the mainline as long as the mainline does not proceed through the diverging route of the turnout.

#6 turnouts or larger shall be used on branchlines and secondary trackage, including sidings and spurs.

#6 turnouts or larger shall be used in yards.

#5 turnouts or larger shall be used in industrial areas.

Turnout Specifications

- All turnouts shall have a metal frog that is insulated from the rest of the rails in the turnout.
- Because of the electrical hookup specifications, power routing turnouts are not necessary and shall not be used.
- Three-way turnouts may be used. However, their usage shall be allowed only when justified.
- Double-slip switches may be used. However, their usage shall be allowed only when justified.
- Curved switches may be used. However, the radii of the turnout routes may not be less than the minimum radius for the type of trackage where they are used.
- Double crossovers are not recommended for mainlines or branchlines because they are seldom used on the prototype. Two single crossovers shall be used instead unless there is no better alternative at the given location.
- Wye (equilateral) turnouts may be used. However, their usage shall be allowed only when conditions justified. Note: the wye turnout of a given frog angle has half as sharp a curve in each off its legs as the curved leg of a regular turnout. For example, a #3 wye turnout has an equivalent curvature in each of its legs of a #6 turnout.
- Turnouts should be arranged so as to eliminate or minimize the possibility of introducing an S curve into the trackage.

Crossings

- Diamonds or crossings may be used. However, special wiring may be necessary to prevent metal wheels from shorting as a train proceeds through the crossing.

Rerailers

- Commercial rerailers shall only be used in hidden trackage.

Turnout Controls

- Turnout controls may route power to the frog in yards and industrial areas where small wheelbase engines are likely to be used.
- Manual turnout controls may be used.
- Stall-type slow-motion turnout motors may be used.
- Solenoid-type turnout controls may be used in hidden staging areas.
- If powered turnout controls are used in complicated trackage areas (i.e. industrial areas or yards), a diagram shall be provided on the fascia to show the relationship of the turnout controls to the actual trackage.

Track Spacing

Mainline, branchline, and secondary tracks shall have a minimum spacing as detailed in Table 1.

Table 1. Track Spacing.

TRACKAGE	MINIMUM SPACING
Tangent track	2 in
Curves of 36 in. radius or greater	2 1/8 in
Curves of less than 36 in. radius	2 ¼ in
Yard and industrial track	2 in

Track

Only Nickel Silver flex track shall be used.

Code 83 shall be used on mainline, branchline, and secondary tracks.

Code 70 may be used in yard and industrial track.

Code 100 may be used in hidden track areas.

Track with concrete ties shall be used only if they are appropriate to the era and locations that are being modeled.

Track shall be held down with spikes installed next to the outside of the rails. Wire brads through the center of the track are not preferred because a brad that is installed too deep can change the gauge of the track. Wire brads may be used on hidden trackage.

Sleeper ties shall be inserted under the rails at the locations where the ends of flex track are joined to other tracks. The molded plastic spike heads shall be removed from the ties. It may be necessary to file the area of the tie that sits under the rails. The sleeper ties shall be installed so that a hump is not caused in the tracks at the joint.

Electrical

An NMRA compatible DCC system shall be used for control of all trains on the Club layout, as voted on by the Club. The display trackage shall be DC powered.

Wiring diagrams and documentation shall be created and maintained as the layout is constructed. The persons who initially wire the layout might not be the same people who have to troubleshoot it later.

The layout shall be divided into power districts. The number of power districts will depend on the layout design. Each power district shall be equipped with a circuit breaker that can be reset either manually or automatically. Bus wires of different colors shall be used in adjacent power districts. The colors for each district shall be determined by the Standards Team as the layout design progresses.

The maximum size of DCC booster will be 5 Amps. Boosters larger than 5 Amps will not be used due the greater potential for damage during short circuits. The capacity of a booster should be sufficient to run several trains and to provide enough power for lighted passenger trains.

Electrical gaps may be cut into the rail either manually or with a cut-off wheel in a rotary tool. Electrical gaps shall be filled with styrene or plastic for insulation. The plastic shall be glued in place and filed to match the rail contour. Commercially available insulated plastic rail joiners may be used as an alternative to cutting gaps in the rail.

Code 12 AWG stranded copper wire shall be used for the layout power buses.

Feeder wires from the track shall be connected to the bus at a minimum of one per every 3-ft piece of flex track.

Feeder wires from the DCC power bus to the track shall be a minimum of 24 AWG.

Feeder wires may be attached to the power bus by soldering. The insulation of the power bus may be split and pushed back, and the feeder wire shall be attached to the bare area. The connection shall be wrapped with electrical tape. Feeder wires may also be attached to the bus wire using insulation displacement connectors.

Feeder wires shall be soldered to the outside of the rail. The solder joint should be painted to be the same color as the rail.

Feeder wires shall not exceed 3 ft in length. If longer feeder wires are needed, then a length

of wire with a smaller AWG value (larger diameter) should be soldered to the 24 AWG wire.

Feeder wires shall be the same color as the power wire that they are connected to.

A Dual DIN cab outlet shall be used at a minimum of every 8 ft along mainline, branchline, or secondary trackage. Note: if the cab bus is longer than 30 ft, then a cab power booster might be necessary.

A Dual DIN cab outlet shall be available at all yard facilities and frequently used industrial areas.

Cat 5 or Cat 6 cable shall be used for the throttle bus.

Provisions may be made for wireless DCC throttles. This section will be defined later after more is known about the capabilities of wireless DCC.

Auto-reversing sections shall be long enough to accommodate train cars that extract power from the track. Therefore, auto-reversing sections shall be at least 15 ft long.

Standards for signaling will be defined at a later date.

Physical Layout Specifications

The visible mainline trackage on the layout shall be a minimum of 48 in. above the floor. The visible branchline trackage on the main deck of the layout shall be a minimum of 44 in. above the floor. Scenery may dip lower than these elevations. Hidden staging tracks may be lower than the 48-inch main level.

An unobstructed vertical clearance of at least 6 in. shall be maintained above the railhead of all hidden storage or staging tracks. This will allow for ease of rerailing and maintenance.

An aisle width of 36 in. or wider is recommended. The minimum width for pinch points on any aisle shall be 30 in.

Controls on the layout fascia shall be protected from inadvertent contact or damage from people moving in the aisles. It is highly recommended that controls on the fascia be recessed at pinch points in aisles.

No permanent duck-unders shall be used on any of the main aisles. Permanent duck-unders may be used for access to isolated areas of the layout. Drawbridge or swing bridge sections may be incorporated into the layout provided that they are located so that they can remain shut during an operating session and not unduly impede the passage of train operators or visitors. If a drawbridge or swing bridge section needs to be opened during an operating session, the bridge section shall incorporate a power interlock system to prevent trains from running through the open bridge. If a drawbridge, swing bridge, or tiltup is used to allow visitors access to the layout, then the tiltup shall not be wider than 4 in. and shall provide a horizontal clearance of at least 36 in. when in the up position. Guardrails shall be installed so that derailed rolling stock cannot crash onto the floor. The guardrails could be Plexiglas or some type of bridge superstructure.

The top of the backdrop shall be a minimum of 84 in. above the floor. The backdrop should be free flowing and 90 deg corners should be avoided.

The subroadbed shall be spline or ½ in. plywood. No particleboard shall be used due to its poor moisture tolerance properties.

Plywood is recommended for the subroadbed for large flat areas such as yards or industrial areas. Spline is recommended for other trackage. Plywood may also be used for mainlines or branchlines. In order to conserve plywood, it is recommended that plywood polygons be used for curves. All plywood subroadbed must be supported on a maximum of 16 in. centers.

Spline subroadbed shall consist of pine strips ¼ in. wide by ¾ in. deep. ¾ in. wide spacers shall be used between adjacent splines.

Homasote roadbed is acceptable. It is recommended that the roadbed be glued to the subroadbed.

The ballast profile of the mainline shall be higher than that of the yards or adjacent spurs and sidings by ¼ in. This can be accomplished by using ¼ in. thick Homasote.

All staging tracks shall be a minimum of 15 ft long. This will accommodate two modern six-axle diesels and twenty 55-ft cars.

All trackage shall be within 24 in. of the aisle or an access hatch. Scenery may extend to 30

in. from the aisle or an access hatch.

The centerline of trackage should be set back at least 2 in. from the front edge of the layout on level sections. On sections of the layout where the land contour on the front of the layout slopes sharply downward away from the tracks, some method should be used to prevent derailed rolling stock from crashing to the floor.

Clearances

All bridges, tunnel portals, or other items that extend over the tracks must provide at least a 3-in. clearance over the railhead. The height of the NMRA Mark IV track gauge is approximately 3 in. The NMRA Mark IV gauge shall be used to determine the location of trackside loading docks.

On tangent trackage, all line side objects shall be located at least 1 in. from the nearest rail.

On curves, all line side objects shall be located at least 2 in. away from the nearest rail.

General Requirements

The names of all towns, control points, junctions, yards, and other important locations shall be labeled on the layout fascia.

Uncoupling Methods

Permanent uncoupling magnets may be used on industrial spurs or other hard to reach locations that are switched on a regular basis. Magnets must be installed in such a manner that they will not cause a properly adjusted coupler to snag on them.

Electromagnets may be installed in areas that are frequently switched and where a permanent magnet would be inconvenient. It is recommended that the electromagnet be installed under the roadbed. The location of the electromagnet shall be indicated by some means that is apparent to the operator.

It is highly recommended that all manual uncoupling be done with a portable uncoupling tool. Lifting the car or locomotive by hand to uncouple it should only be done as a last resort.

Variances

All requests for variances will be reviewed by the Standards Team on a case-by-case basis.

Variances that are granted shall be documented in Appendix A to the Standards document.

Materials

Materials used to construct the subroadbed must be of high quality so that the track is not prone to shifting thereby causing derailments. Plywood must be of BCX grade or better. If pine is used to build supports for the roadbed, then it must be of #2 grade or better.

References

NMRA Standards as recorded on the NMRA website as of July 2006.

Armstrong, J., Track Planning for Realistic Operations, Kalmbach Publishing, Milwaukee, Wisconsin, 1979.

Version 1, Adopted by the Hawkeye Model Railroad Club August 18, 2006.

Appendix A: Variances to the Standards

The date of the acceptance of the variance, a detailed description of the variance, and a name of the person accepting the variance must be provided in Appendix A. If the Standards are revised, then a variance could become a part of the Standards and removed from Appendix A.

Appendix B: How to Lay Out a Horizontal Easement

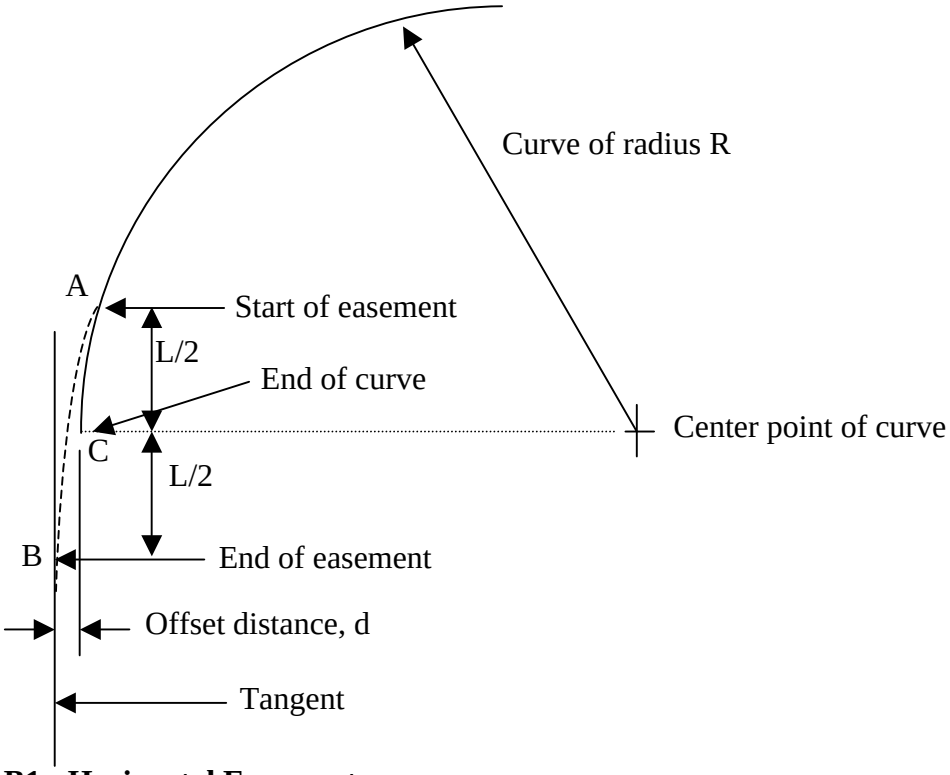

Figure B1: Horizontal Easement.

1. Locate the center point of the curve and draw the curve. Find the point where the circular curve should stop. Label this point C.
2. Determine the offset distance, d, to the tangent. Note that steps 1 and 2 could be reversed, that is (1) draw the tangent and (2) locate the center point of the curve a distance of R + d from the tangent and draw a curve of radius R. The offset is given by d = L * L/24/R, where L is the length of the easement. For example, if L = 14 in. and R = 36 in., then d = (14)(14)/24/36 = 0.226 in. or 0.25 in.
3. From the Standards, the length of the easement is L = 14 in. Measure a distance of 7 in. on the curve from point C to find the point where the easement starts. Label this point A. Measure a distance of 7 in. from point C to find the point where the spiral easement ends on the tangent. Label this point B.
4. Place a bent wooden yardstick between the points that were determined and draw the easement. See the dashed line on the figure. The yardstick should be tangent to the tangent line at point B and the curve at point A.

Appendix C: How to Lay Out Super-elevation.

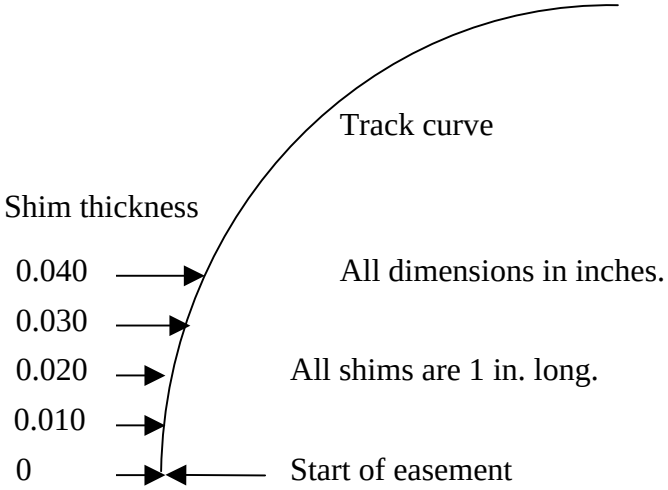

Figure C1: Super-elevation.

1. Layout the intended track path with easement.
2. Measure 4 in. from the start of the easement. Place a 0.010 in. styrene shim under the outside rail.
3. Go 4 in. more on the curve. Place a 0.020 in. styrene shim under the outside rail.
4. Go 4 in. more on the curve. Place a 0.030 in. styrene shim under the outside rail.
5. Go 4 in. more on the curve. Place a 0.040 in. styrene shim under the outside rail.
6. The maximum allowed super-elevation is 0.040 in. Place 0.040 in. shims about every 4 in. under the outside rail until the point is reached on the curve where the transition back to flat track begins. For the transition down, use the same shims as for the transition up except in the reverse order.

Appendix D: The Polygon Method.

Purpose:

The polygon method is a way to use polygons to construct curves and helixes and is a way to reduce the waste of materials. As shown in Fig. D1, three polygons are used to form a 90 deg curve. The track is the dashed line. By adding more polygons, a full circle could be made from 8 polygons, and by having a grade, the polygons could be raised to pass over themselves. Figure D2 shows that, with a little additional cutting, the polygons can be used to achieve a meandering path for the track. The polygons can be joined together by using splices fastened underneath at the joint between two polygons or by other methods.

Once the sizes of the polygons are determined, the polygons can be cut from a sheet of plywood. A sample arrangement of the polygons on a sheet of plywood is shown in Figure D3. The process begins by cutting strips for the polygons and then cutting the ends at an angle of 22.5 deg. Note that by using polygons, there is very little waste of the plywood.

Instead of using an angle of 22.5 deg, which results in two polygons forming 90 deg, an angle of 15 deg results in three polygons forming 90 deg. The 15 deg angle requires two joints but uses less material than the 22.5 deg angle.

Size of polygons:

The size of a polygon can be determined either graphically or by using trigonometric relations. Both methods are discussed. The discussion assumes that 8 polygons form a circle.

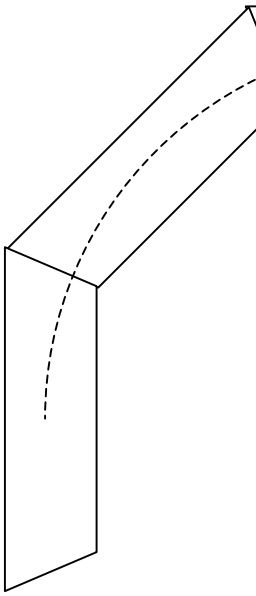

Figure D1: 90 deg bend.

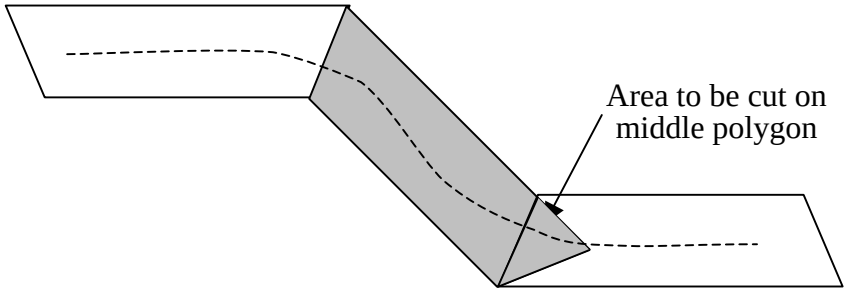

Figure D2: Meandering path.

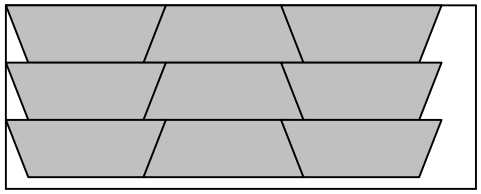

Figure D3: Plywood sheet.

Graphical Method:

The graphical method is shown in Figure D4. It is suggested that a piece of cardboard or similar material be used to draw out a polygon in full size for a template. Assume the track, represented by a dashed line, with a curve of radius R0 is desired. Multiple tracks are also possible. The inner and outer clearance curves with radii R2 and R1 are selected and drawn on the cardboard. For example, if R0 = 36 in. and using a 2 in. clearance, then R1 = 38 in. and R2 = 34 in. The steps are:

1. Draw arcs of radii R1 and R2.
2. Draw line AA passing through the center of the arcs.
3. Draw a line at an angle of Th = 22.5 deg on both sides of AA.
4. Draw a horizontal line labeled BB that is tangent to the arc of radius R1 and perpendicular to AA.
5. Draw a second horizontal line labeled CC that is parallel to BB and intersects with the 22.5 deg lines and arc of radius R2.
6. Connect the end points of the horizontal lines along the 22.5 deg lines to form a polygon.
7. Cut out the polygon as a template for use on the plywood sheet.

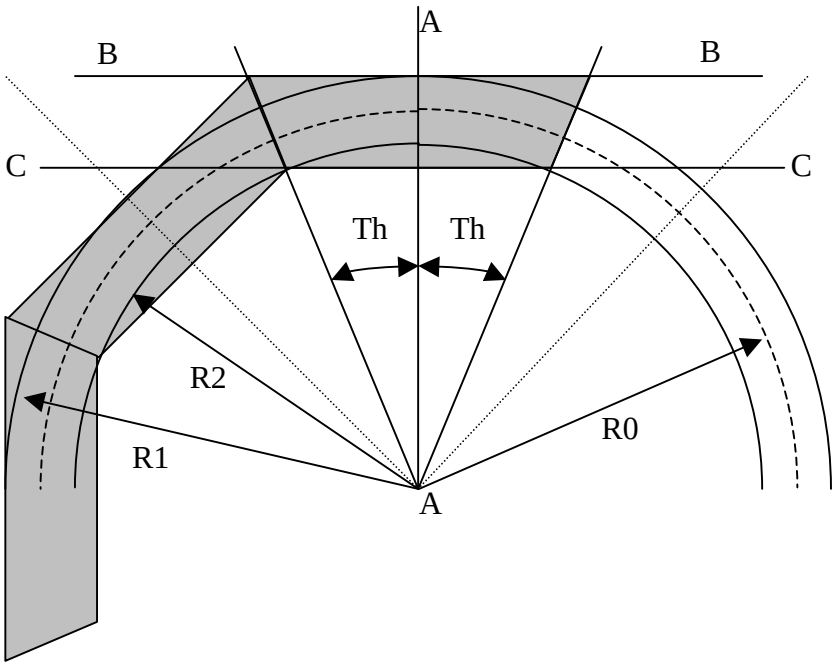

Figure D4 Graphical description of polygons.

Trigonometric method:

The sketches in Figure D5 are used to determine the trigonometric relations. The steps to use this method are:

1. Determine R1 and R2 as in the graphical method. The angle Th = 22.5 deg.
2. Calculate the following values using R1, R2, and Th.

   x1 = R1 tan(Th)
   x2 = R2 sin(Th)
   y2 = R2 cos(Th)

   L1 = 2 x1
   L2 = 2 x2
   W = R1 – y2

   where L1 is the length of the longer side, L2 the length of the shorter side, and W the width of the polygon.

3. Using Th = 22.5 deg and the computed values of L1, L2, and W, draw the polygon on a template or directly on a plywood sheet.
4. As an example of the trigonometric method, let R2 = 34 in., R1 = 41 in., and Th = 22.5 deg. Then, x1 = 16.983 in., x2 = 13.011 in., y2 = 31.412 in. Finally, L1 = 33.966 in., L2 = 26.023 in., W = 9.588 in. A spreadsheet is available for these calculations. A calculator with trigonometric relations could also be used.
5. As another example, let R2 = 34 in., R1 = 41 in., and Th = 15 deg. Then, L1 = 21.97 in., L2 = 17.68 in., and W = 8.16 in. Note that W is 1.43 in. narrower than W when Th = 22.5 deg..

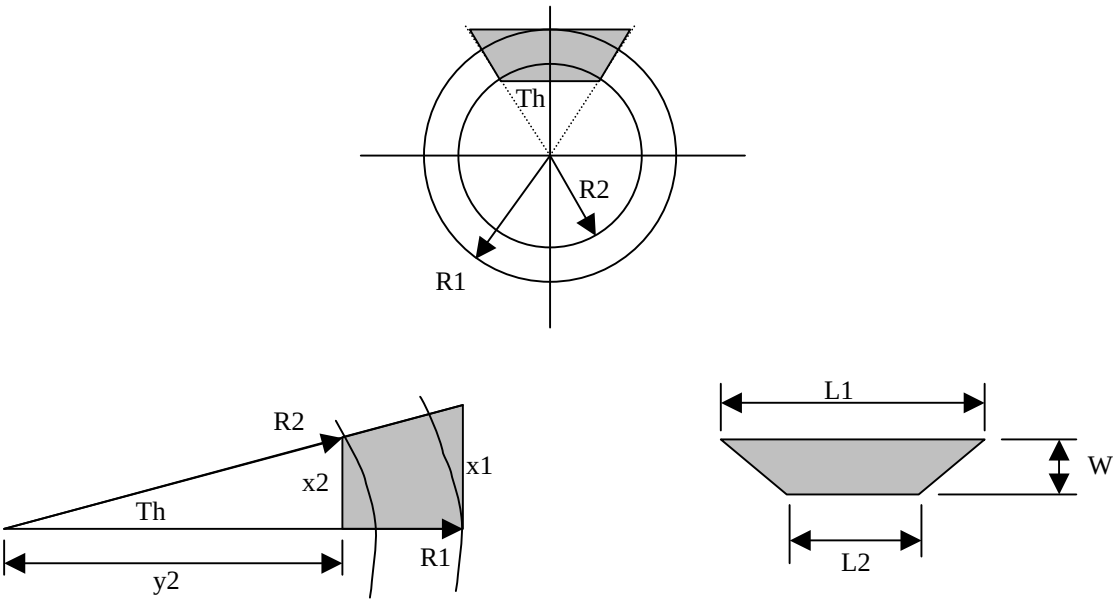

Figure D5 Trigonometric relations.