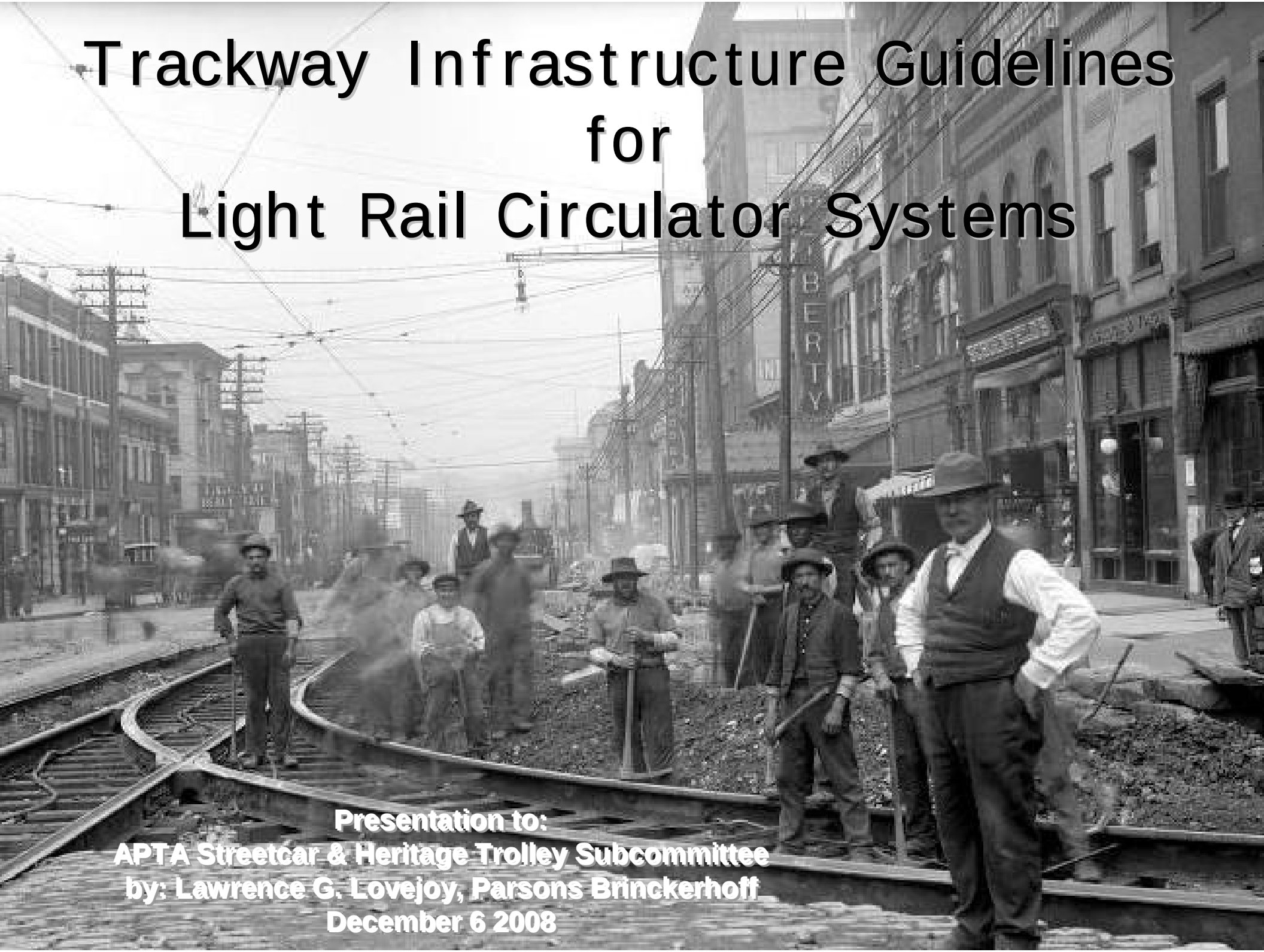
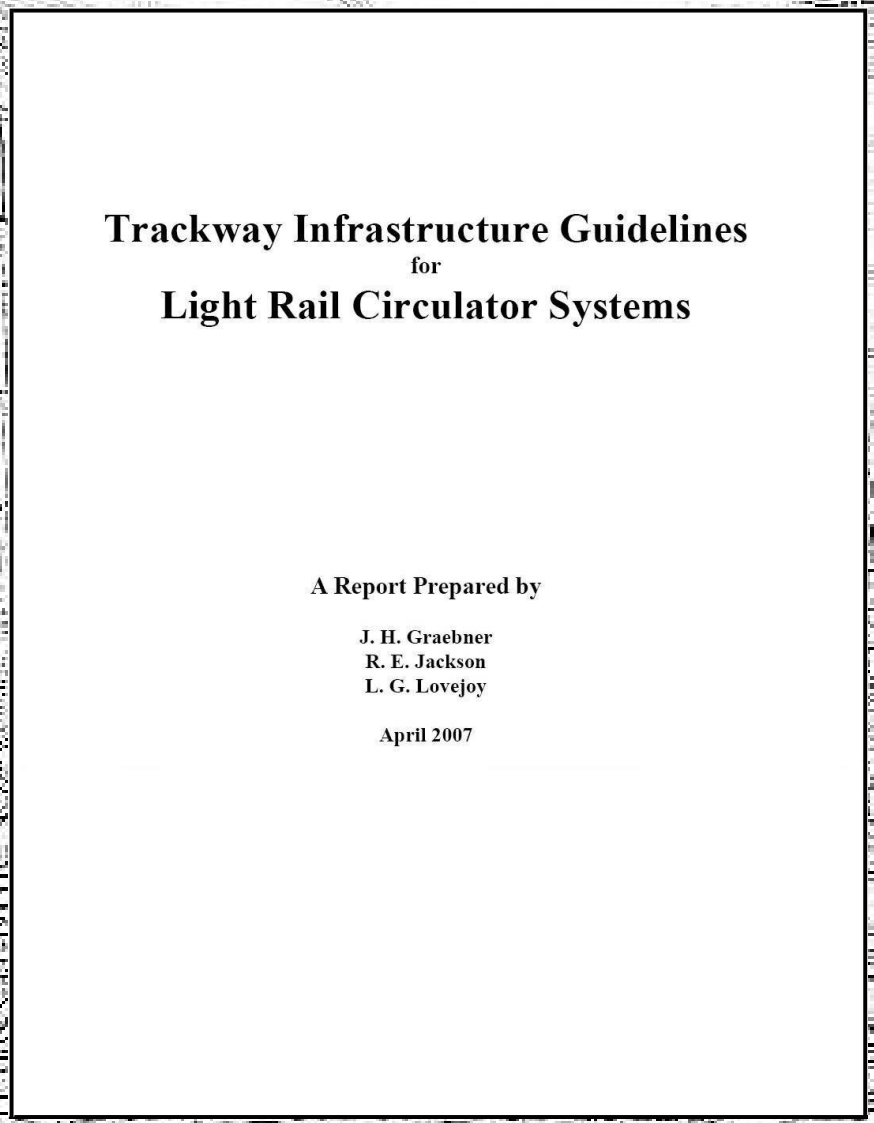
Trackway Infrastructure Guidelines for Light Rail Circulator Systems



Presentation to:
APTA Streetcar & Heritage Trolley Subcommittee
by: Lawrence G. Lovejoy, Parsons Brinckerhoff
December 6 2008

Trackway Infrastructure Guidelines for Light Rail Circulator Systems


Trackway Infrastructure Guidelines
for
Light Rail Circulator Systems

A Report Prepared by

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April 2007

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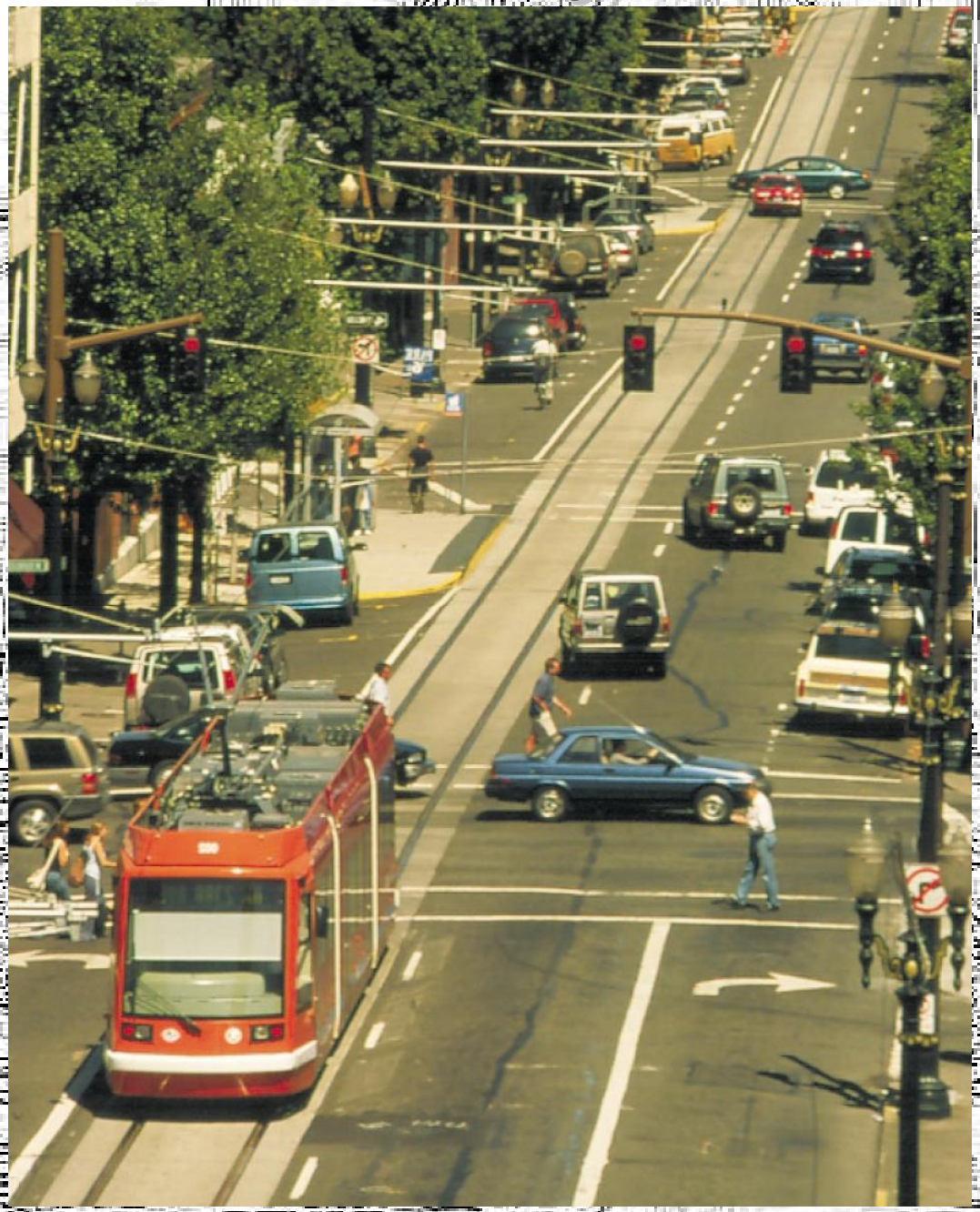
Light Rail Circulator Systems

- Typically provide transit service within a single municipal jurisdiction
- Typically don't require speed, capacity and multiple-unit capability of line-haul LRT
- Must be able to negotiate street patterns in the urban center, often in mixed traffic
- Should "fit in" with the scale of residential areas contiguous to the urban center
- Often require rolling stock which can negotiate smaller radius curves than customary light rail standards

Light Rail Circulator Systems

Recently constructed examples:

- Portland



Light Rail Circulator Systems

Recently constructed examples:

- Portland
- Tampa

Light Rail Circulator Systems

Recently constructed examples:

- Portland
- Tampa
- Kenosha

Vehicle Size and Curving Considerations

De facto US LRT Standards:

- Minimum Curve Radius: 82 feet / 25 m
- Vehicle Width: 2650 mm / 8.7 feet
- Track Gauge: 56 ½ inches / 1435 mm

Typical European Tramway Characteristics:

- Minimum Curve Radius: 15 to 18 m (49 to 59 ft)
- Vehicle Width: 2200 mm to 2650 mm (7.2 to 8.7 feet)
- Track Gauge: 1000 to 1435 mm

Trackway Considerations

GUIDELINE #4:

In optimizing the trackway/vehicle relationship ensure that the chosen vehicle curving capabilities do not excessively constrain site selection for the maintenance facilities and storage yards. Evaluate the trade-offs of a reduced number of vehicle suppliers and possibly higher vehicle prices versus greater costs for the fixed facilities if the site location is constrained by the vehicle capabilities.

Track Design Considerations

GUIDELINE #5:

Ensure that those parties responsible for wheels and rails are working in concert to produce optimum compatibility between the two subsystems. Wheel gauge, track gauge, check gauge, and all new and worn dimensions should all be mutually agreed to and initial drawings documenting all parameters should be developed before any serious design work takes place.

Track Design Considerations

GUIDELINE #6:

When choosing a track designer, it is of great importance that the one chosen has demonstrable knowledge of streetcar track and successful design experience. Many track designers have primarily a railroad background, which by itself is not qualification for design of Light Rail Circulator System track with small radius curves and possibly complex and compact shop and yard layout.

Track Design Considerations

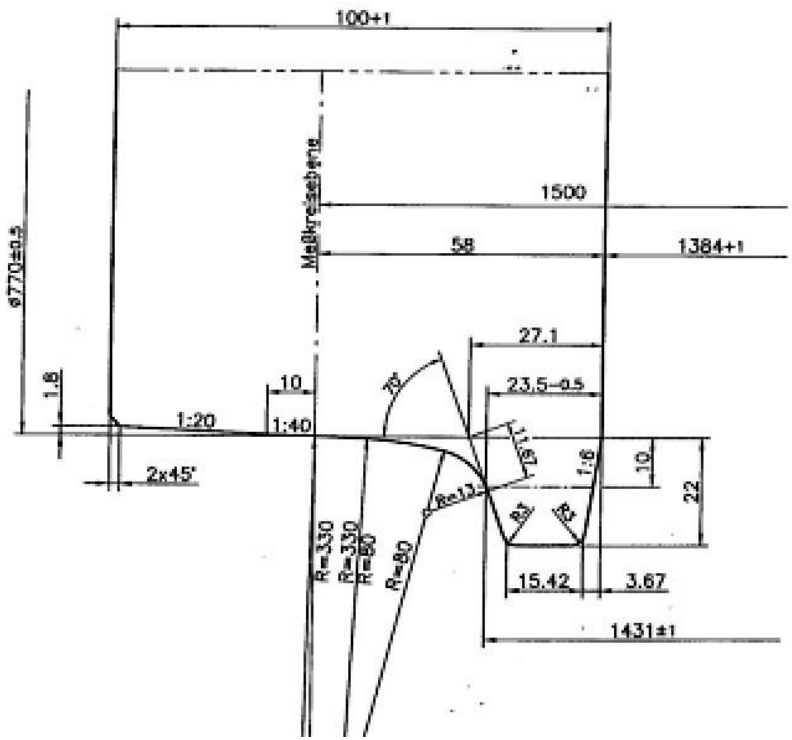
Rails and Wheels

They are a system – not every wheel contour will perform satisfactorily on every rail section.

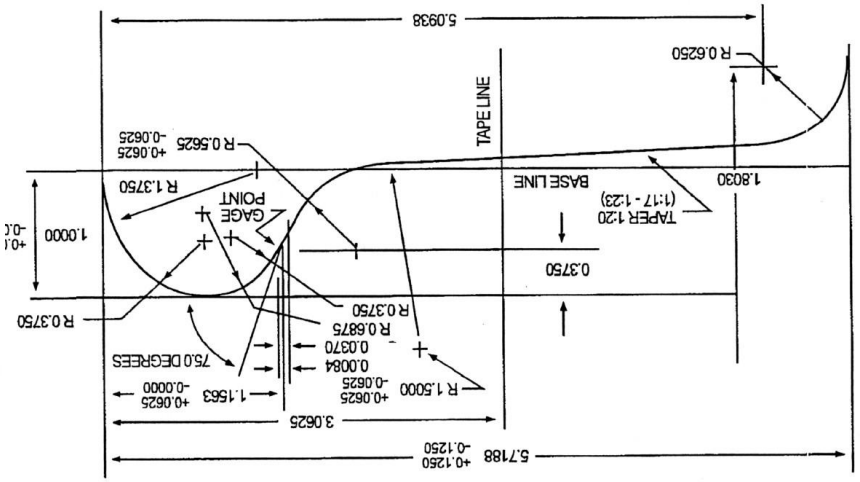
The AAR freight wheel contour (or any wheel which resembles it) is likely not the best choice for any LRT operation with tight curvature in embedded track situations.

Track Design Considerations

Wheel Tread and Flange Contours



Typical European Tram Wheel



AAR 1B Narrow Flange Wheel

Track Design Considerations

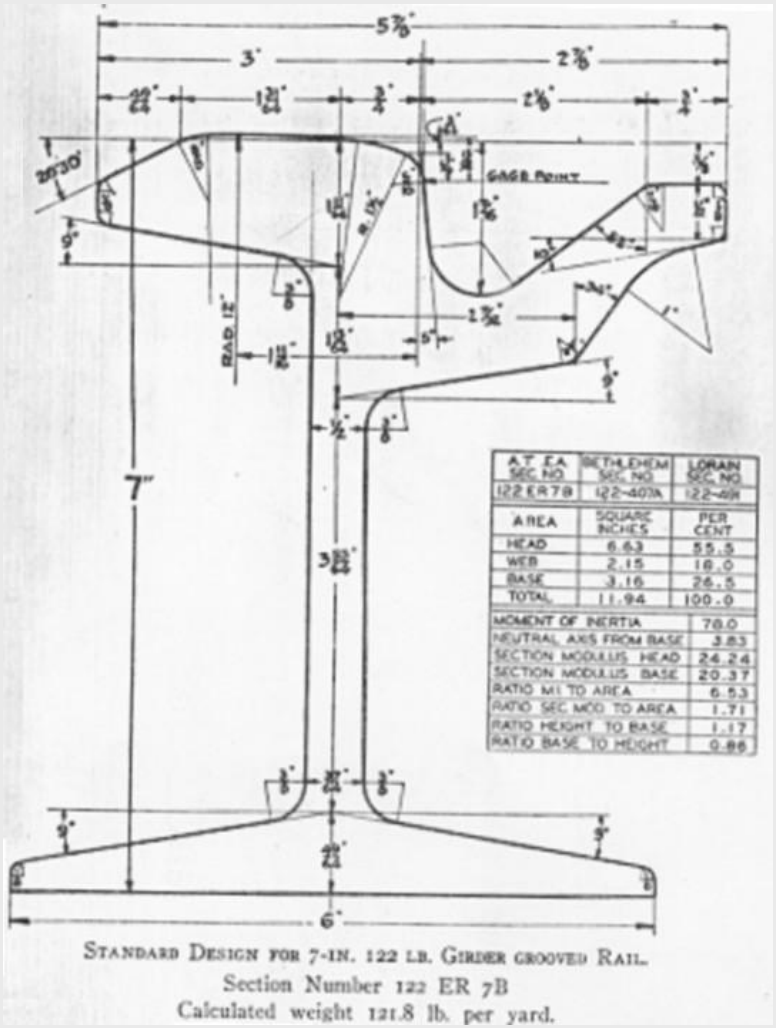
Rails and Wheels

The wheel / rail interface surfaces should be close to identical regardless of whether the track is embedded in the street or open ballasted track.

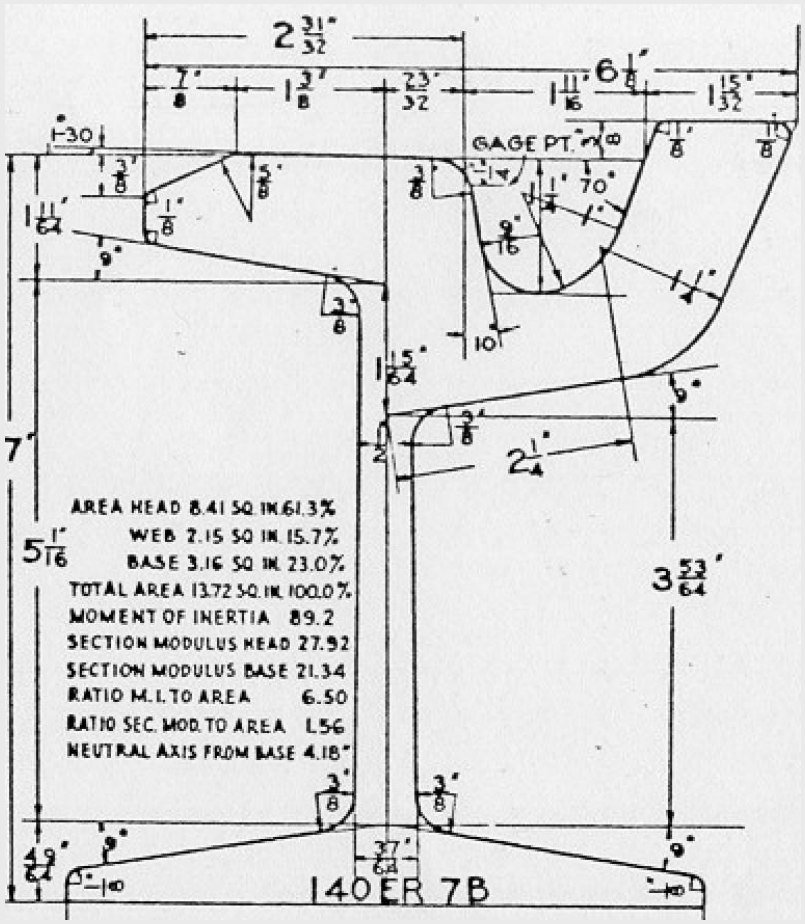
Achieving the above with a mixture of domestic tee rail and overseas girder rails is difficult at best.

Track Design Considerations

American Transit Engineering Assn. Girder Rails



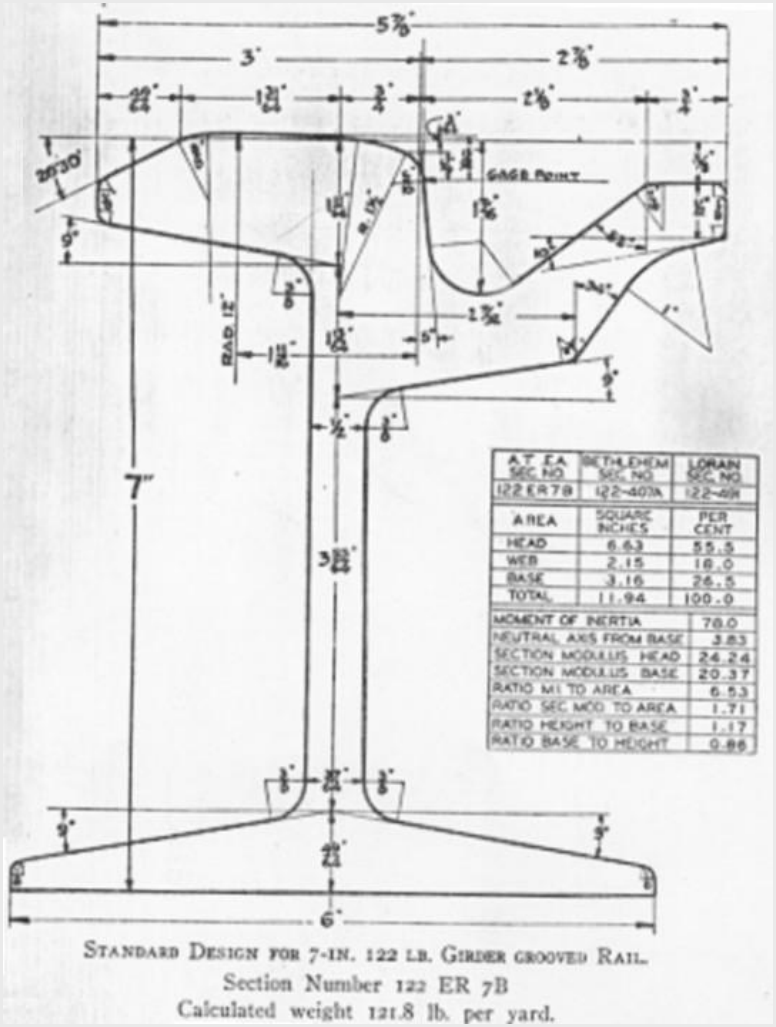
STANDARD DESIGN FOR 7-IN. 122 LB. GIRDER GROOVED RAIL.
Section Number 122 ER 7B
Calculated weight 121.8 lb. per yard.



Not rolled since the 1950's

Track Design Considerations

American Transit Engineering Assn. Girder Rails



STANDARD DESIGN FOR 7-IN. 122 LB. GIRDER GROOVED RAIL.
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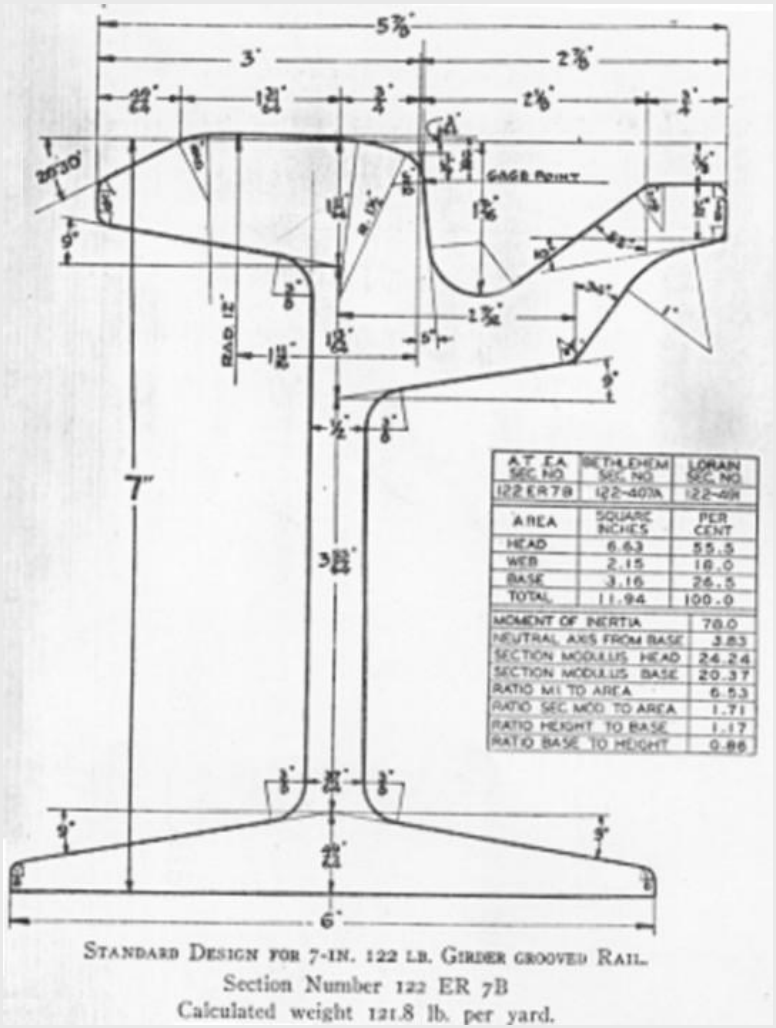
Calculated weight 121.8 lb. per yard.

Trilby Rail

Trilby Hat

Track Design Considerations

American Transit Engineering Assn. Girder Rails



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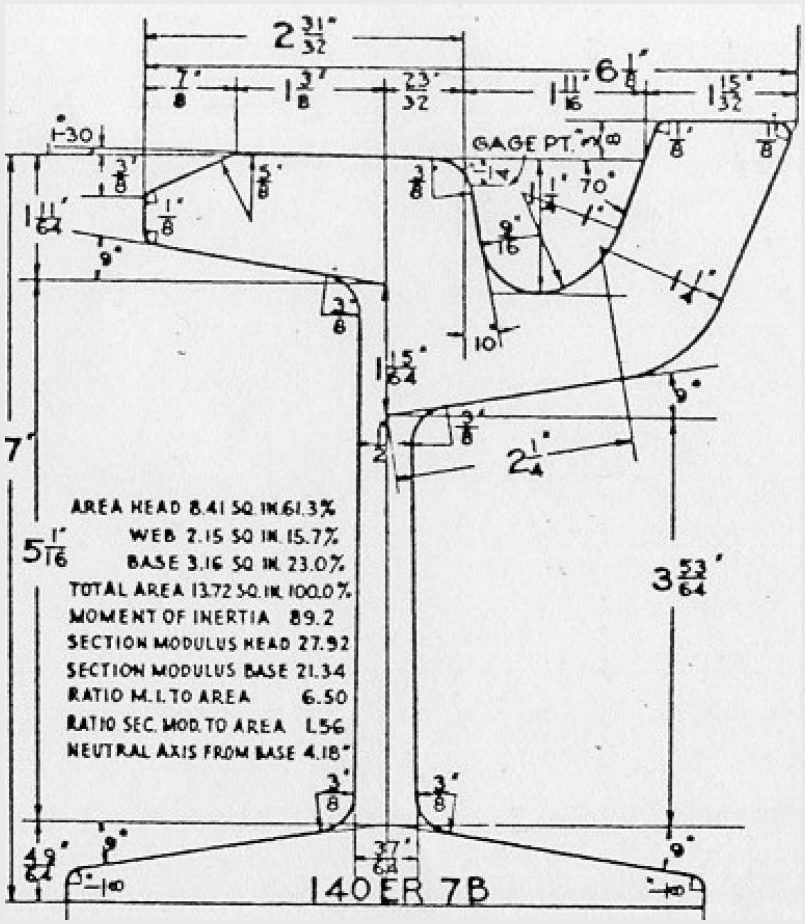
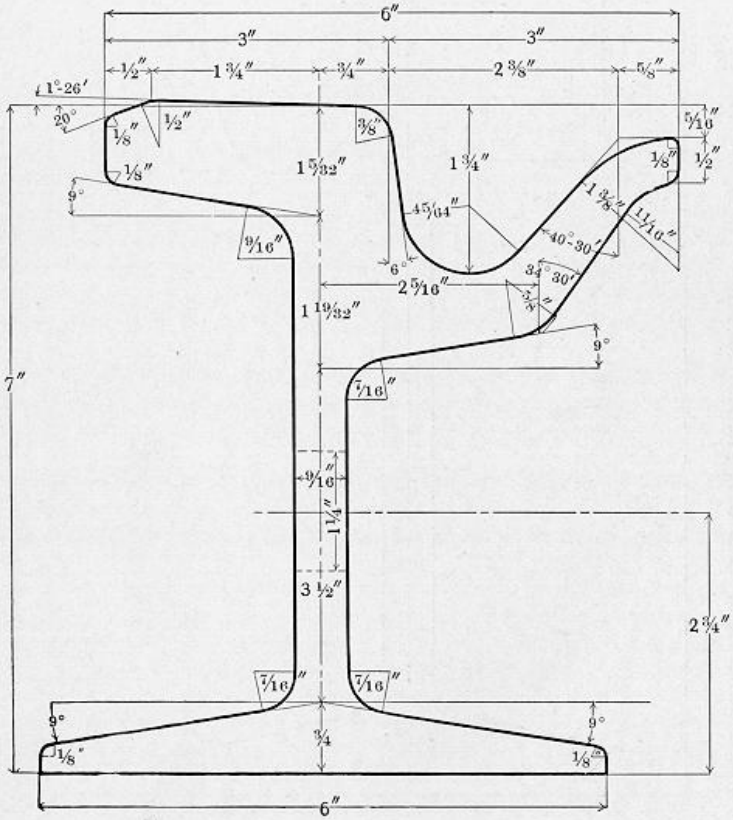


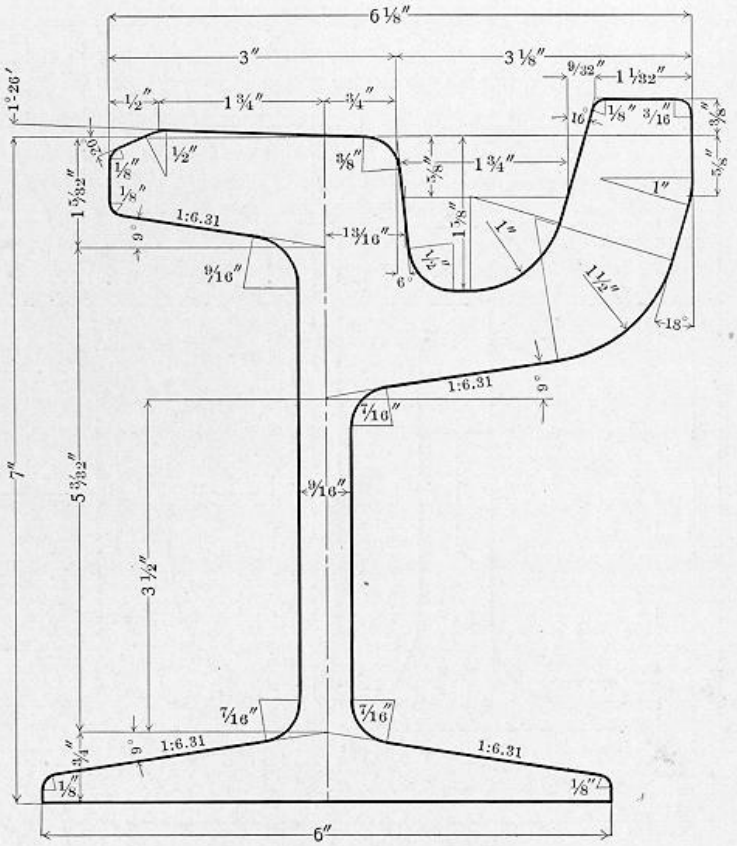
Not rolled since the 1950's

Track Design Considerations

American Railway Engineering Assn Girder Rails



Section 128 No. 456. 128 pounds per yard
Rail is A.R.E.A. standard No. 128-RE-7A

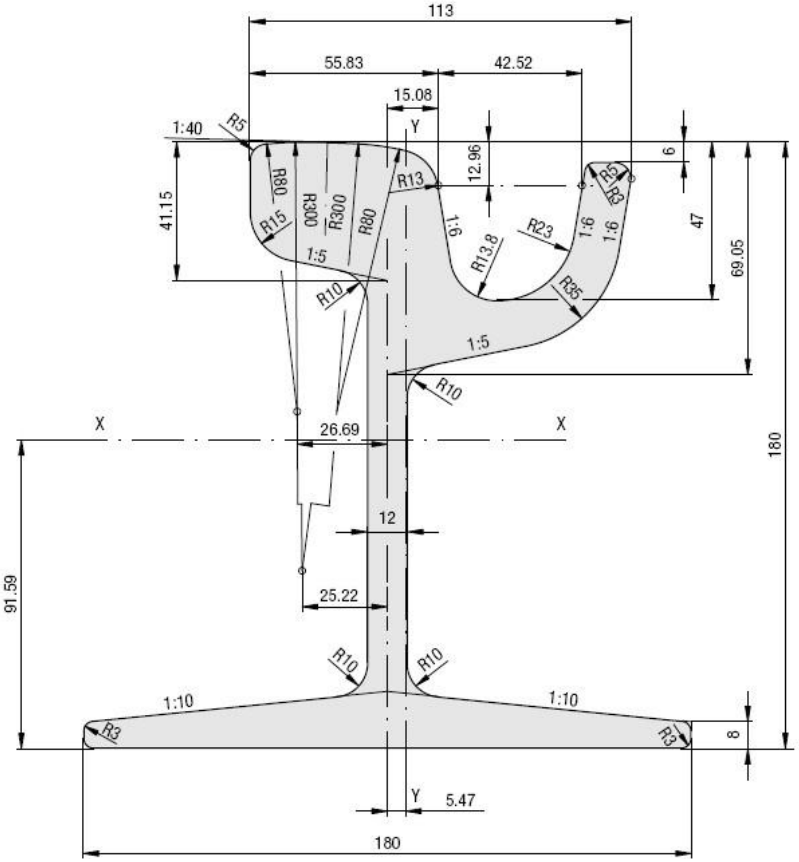


Proposed Guard Rail. 149 pounds per yard
Rail is A.R.E.A. standard No. 149-RE-7A

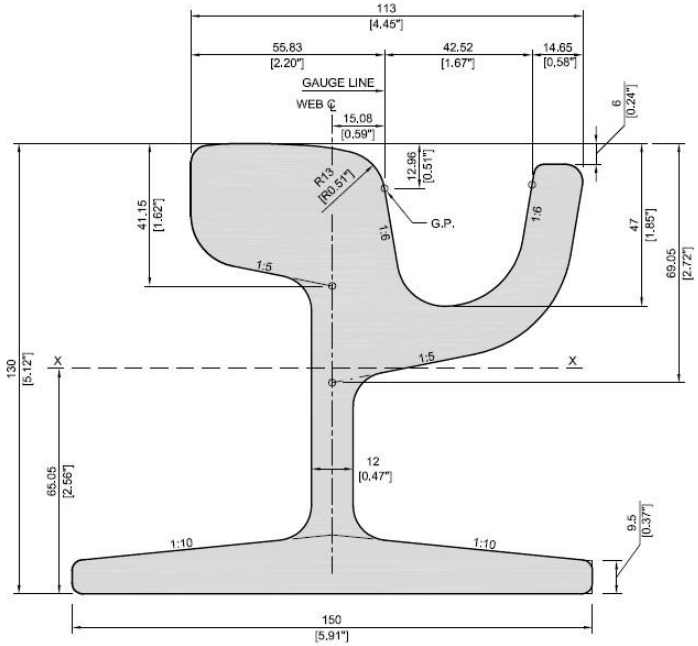
Not rolled since the 1980's

Track Design Considerations

C E N (European Committee for Standardization) Groove Rails



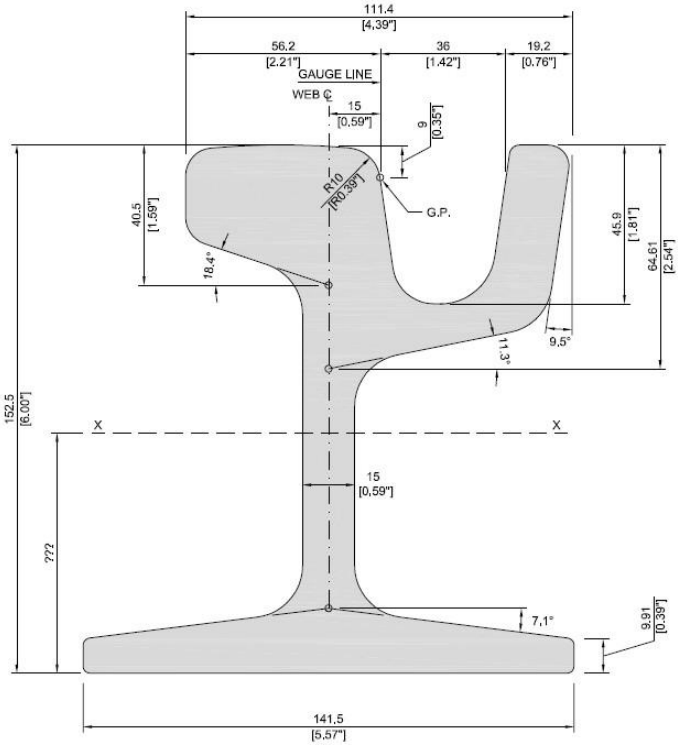
59Ri2 (Ri59-13)



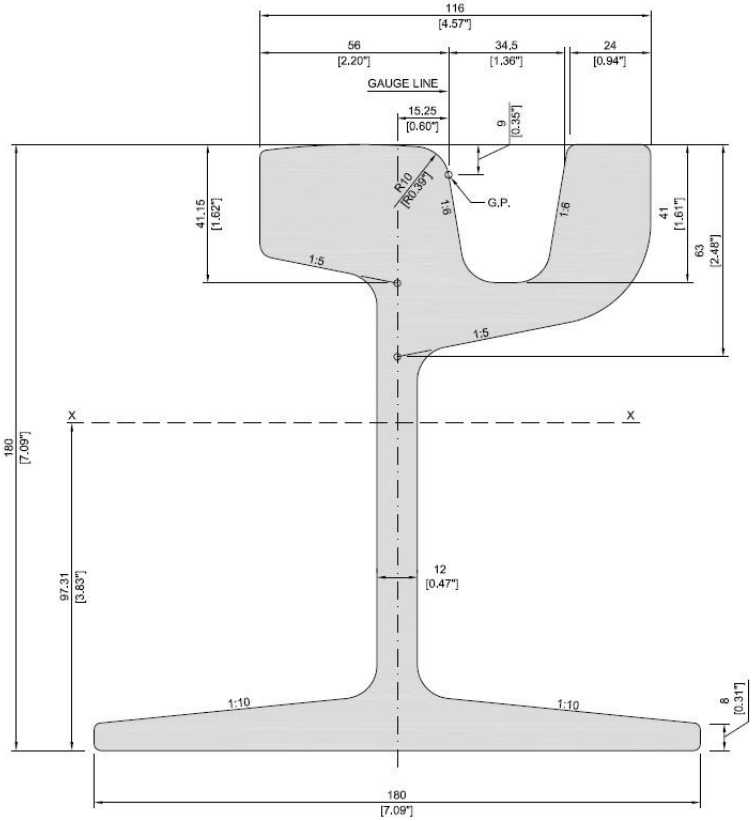
51Ri1 (Ri51)

Track Design Considerations

CEN (European Committee for Standardization) Groove Rails



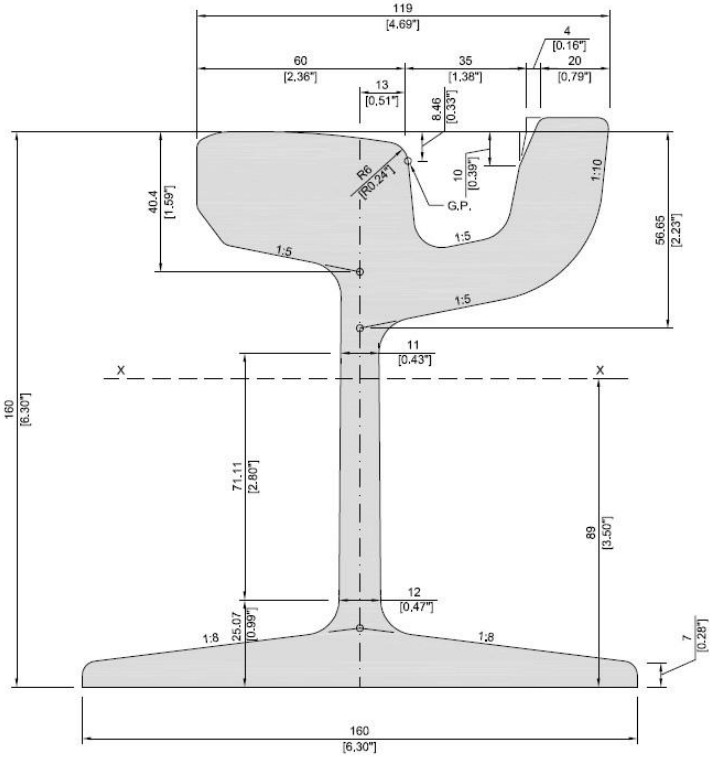
55G1 (35GP)



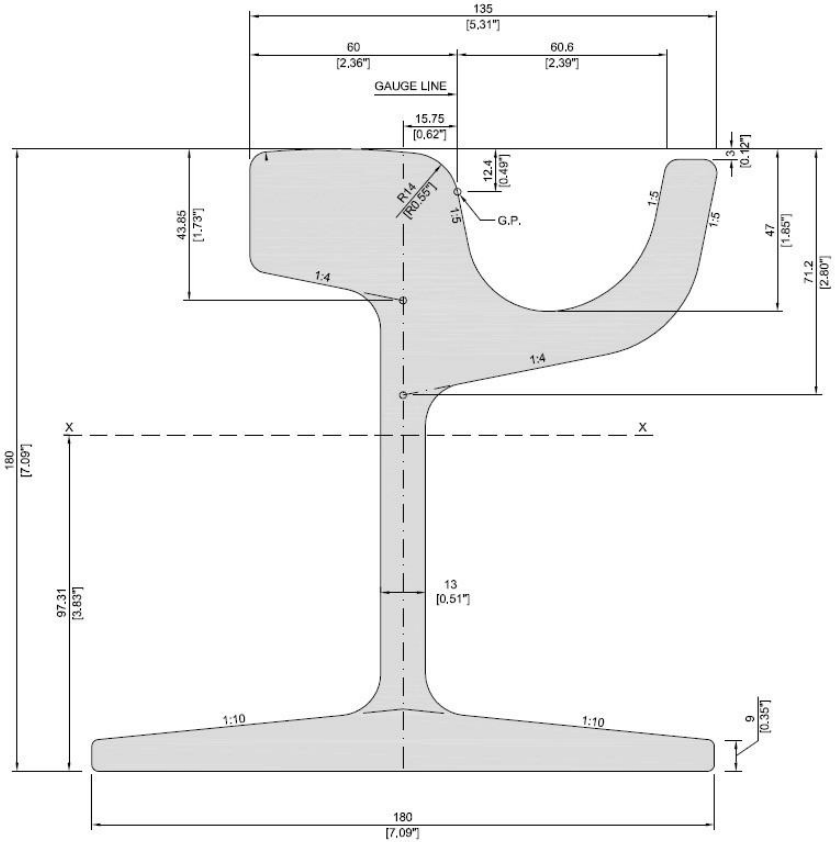
62R1 (NP4a)

Track Design Considerations

CEN (European Committee for Standardization) Groove Rails



56C1 (1c)



67R1 (Ph37)

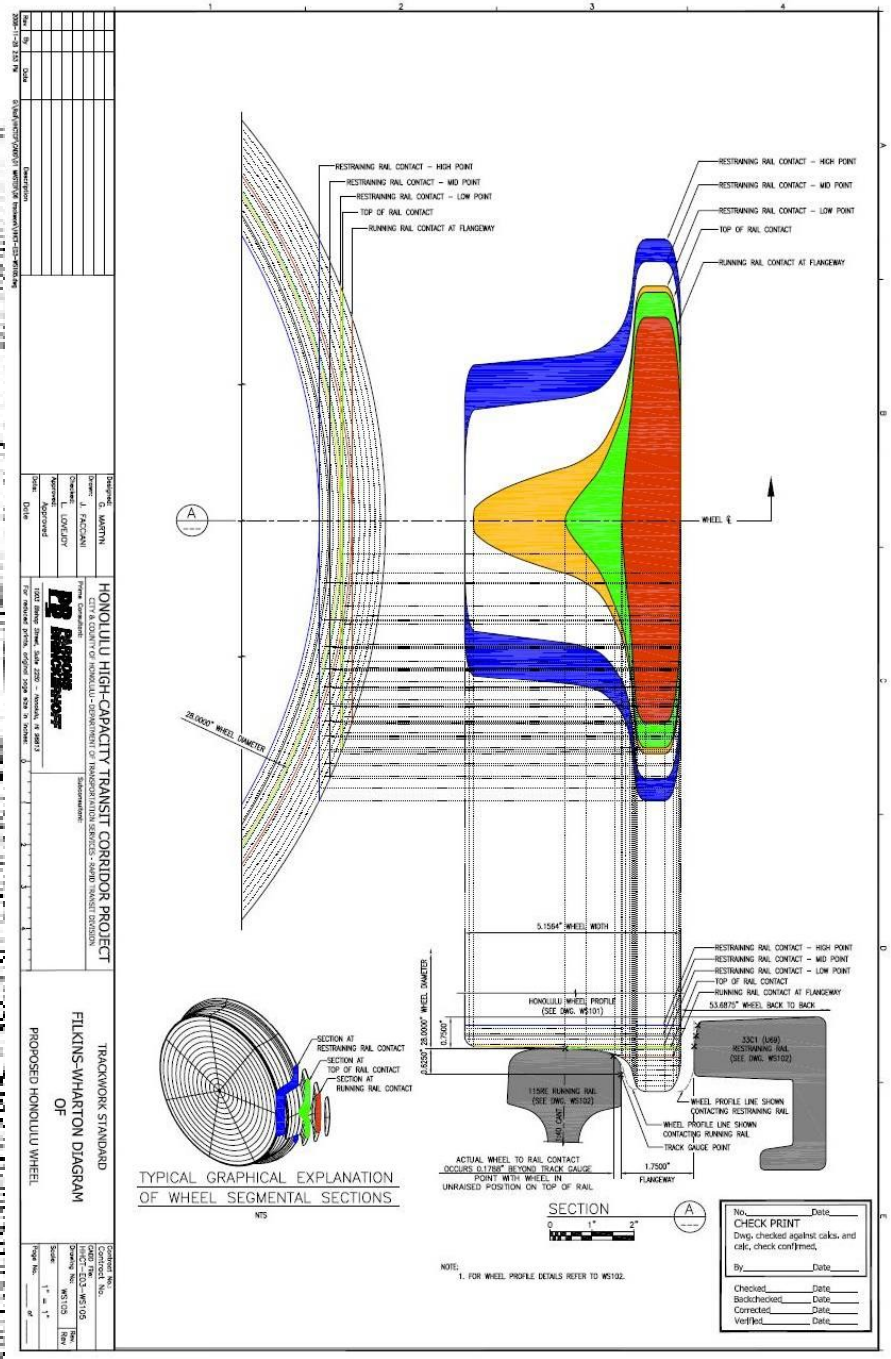
Track Design Considerations

GUIDELINE #7: Part 1

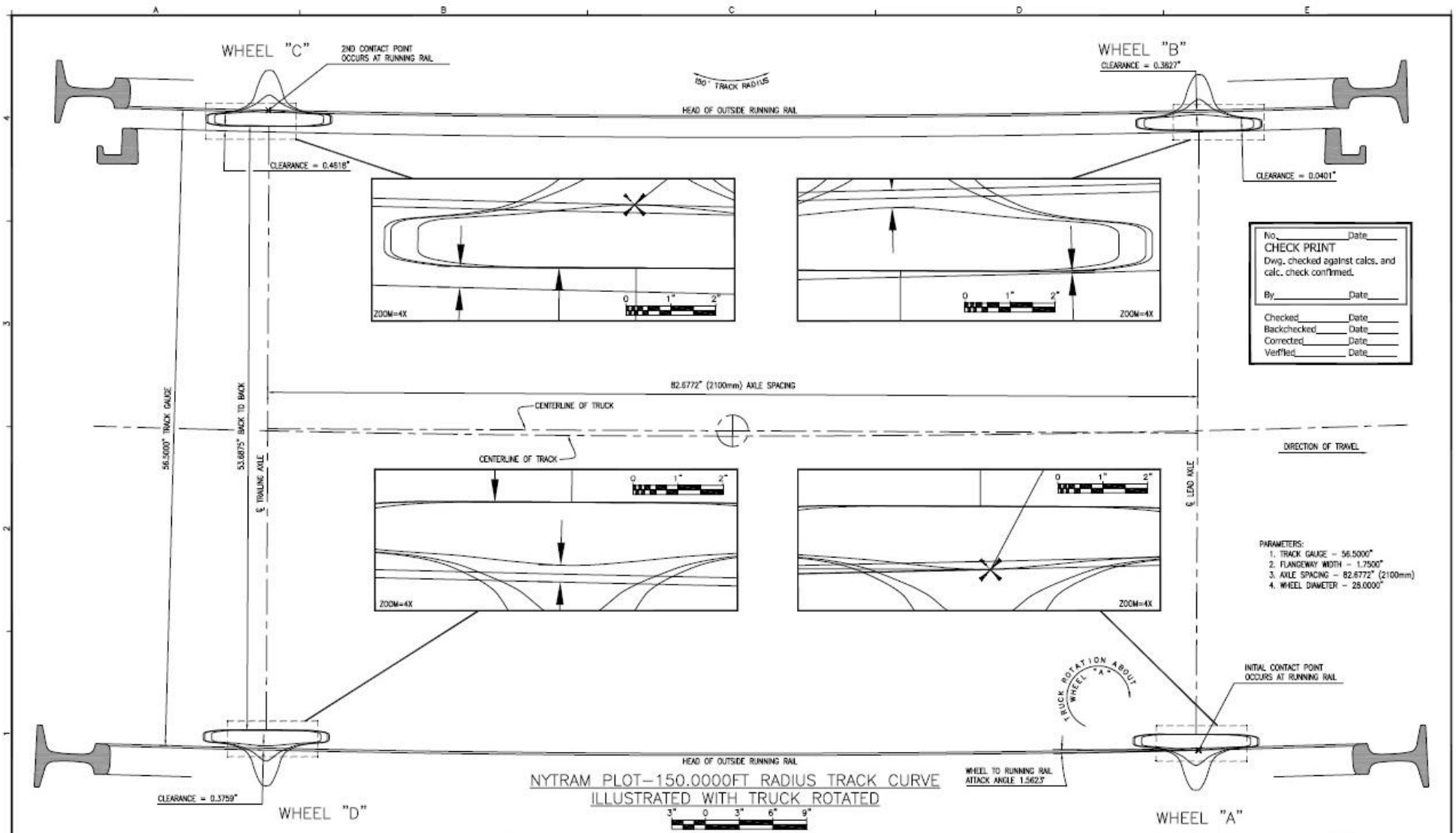
If grooved / girder rail is used, then a wheel flange profile optimized for the girder rail should be adopted.

Both the gauge and guard side flange angles from vertical and the tip radii on both the running rail and guard side of the flange should be analyzed for use on curve radii below 15 meters (49 feet) and adjusted for perfect compatibility if found necessary.

Track Design Considerations



Track Design Considerations



Track Design Considerations

GUIDELINE #7: Part 2

Alternatively, consider adopting wheel flange profile and matching rail section standards already in successful use on a European property which has similar curve radii to those to be used on the Circulator System.

The flange should include the typical flat tip that works best with flange-bearing frogs, crossings, and mates.

Track Design Considerations

GUIDELINE #8:

Bolted joints should be eliminated in embedded track as much as possible.

Absolutely unavoidable bolted joints should be sandblasted and epoxy glued.

Under no circumstances use spring washers in embedded rail joints

Track Design Considerations

GUIDELINE #9: Part 1

To avoid potential problems due to gauge inaccuracies, all specialwork containing turnouts and small radius curves should be designed, fabricated and constructed with a positive means of maintaining the gauge.

Track Design Considerations

GUIDELINE #9: Part 1

Track Design Considerations

GUIDELINE #9: Part 1

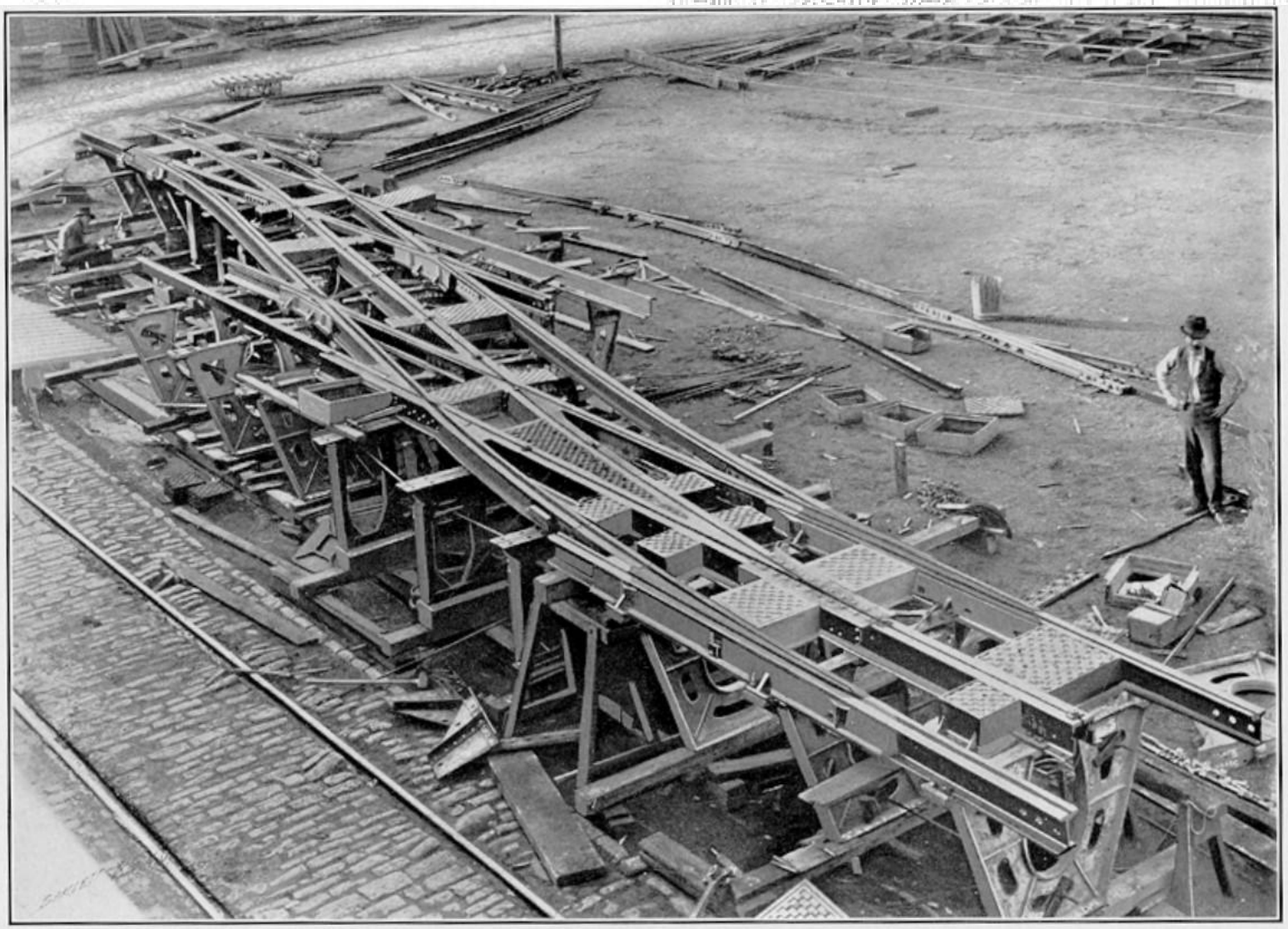
Track Design Considerations

GUIDELINE #9: Part 2

Full shop assembly including the gauging devices should be performed. All gauging should be carefully checked during shop assembly so as to detect any gauge device dimensional errors.

Track Design Considerations

GUIDELINE #9: Part 2



Track Design Considerations

GUIDELINE #9: Part 2

Consider fabricating wheel-pair templates which will accurately simulate both new and worn wheel conditions. Supply of these can be made a part of the track supply contract.

Alternatively, a Circulator vehicle truck can be pushed around through the track layout to determine if appropriate rail/wheel interaction is occurring, but it should be recognized that the worn wheel condition will not be present without modification.

Track Design Considerations

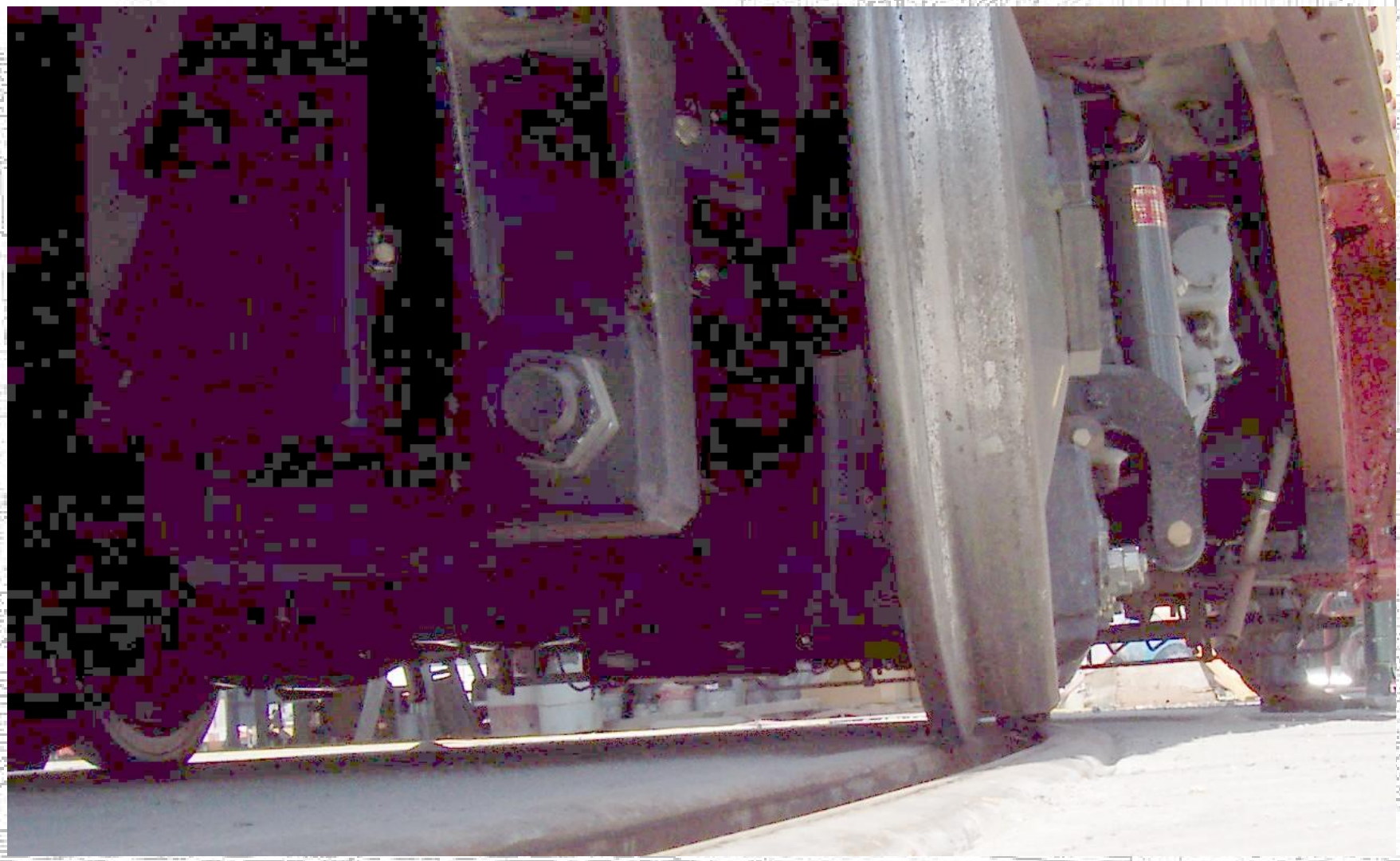
GUIDELINE #9: Part 3

The templates or a vehicle truck can be used to check gauging of running and guard rail surfaces.

Regardless of the verification method used, checks must be done before placement of embedding paving makes corrective actions extremely difficult and costly.

Track Design Considerations

GUIDELINE #9: Part 3



Pavement Design Considerations

GUIDELINE #11

Careful attention must be given to pedestrian crosswalks. Flangeways must comply with ADA in any locations where pedestrians can be expected. Crosswalks should be excluded from areas of moving switches and discouraged from any areas of wide specialwork fabrications, such as frogs.

Pavement Design Considerations

GUIDELINE #11

Pavement Design Considerations

GUIDELINE #13

Where the Circulator track is in a shared traffic lane, the pavement construction must be sufficiently robust to withstand heavy traffic with virtually no maintenance. Contemporary manufactured architectural "pavers" are seldom up to such loadings, particularly in northern climates where intrusion by salt brine is likely.

Pavement Design Considerations

GUIDELINE #13

Pavement Design Considerations

GUIDELINE #14

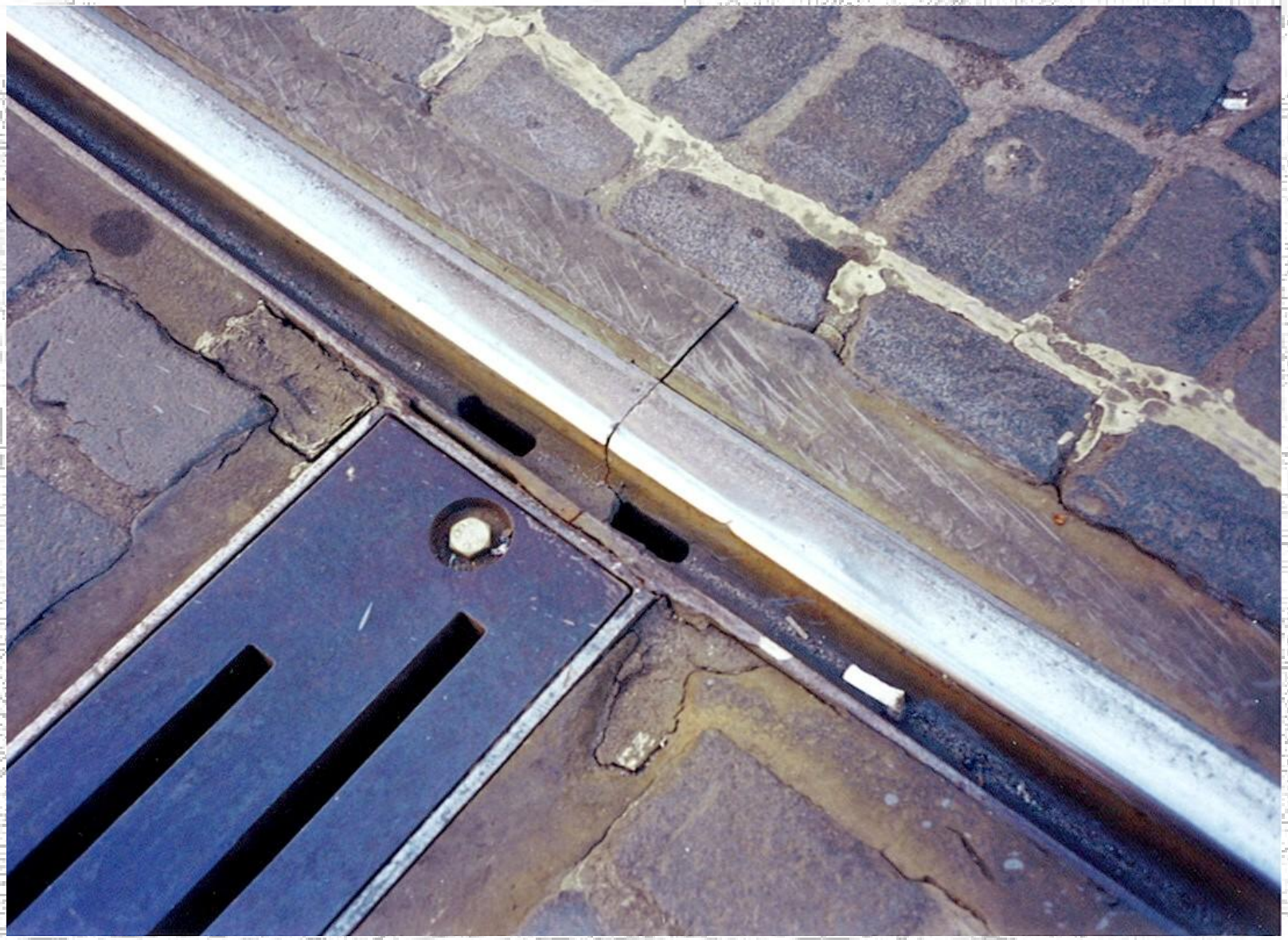
Storm water runoff carries along with it street detritus which can cause maintenance problems. Flangeways in embedded track therefore must be drained:

- *Upstream of embedded special trackwork*
- *Upstream of transitions to open ballasted track.*

Flangeways should also be drained at the low point of vertical curves.

Pavement Design Considerations

GUIDELINE #14



Pavement Design Considerations

GUIDELINE #16

In a mixed traffic environment, any visually obvious joint in the pavement that is parallel to the rail should ideally be outboard of the Circulator vehicle dynamic envelope, particularly if the adjoining lane is used for parking. Often, this joint will coincide with the maintenance responsibility limit.

Pavement Design Considerations

GUIDELINE #16

Pavement Design Considerations

GUIDELINE #16

Pavement Design Considerations

GUIDELINE #17

Coordinate with roadway pavement design to minimize cross slope in the track.

It is not essential to eliminate cross slope.

Negative superelevation is acceptable provided that speeds are limited to control the overall unbalance to acceptable levels.

Track Geometry Considerations

GUIDELINE #18

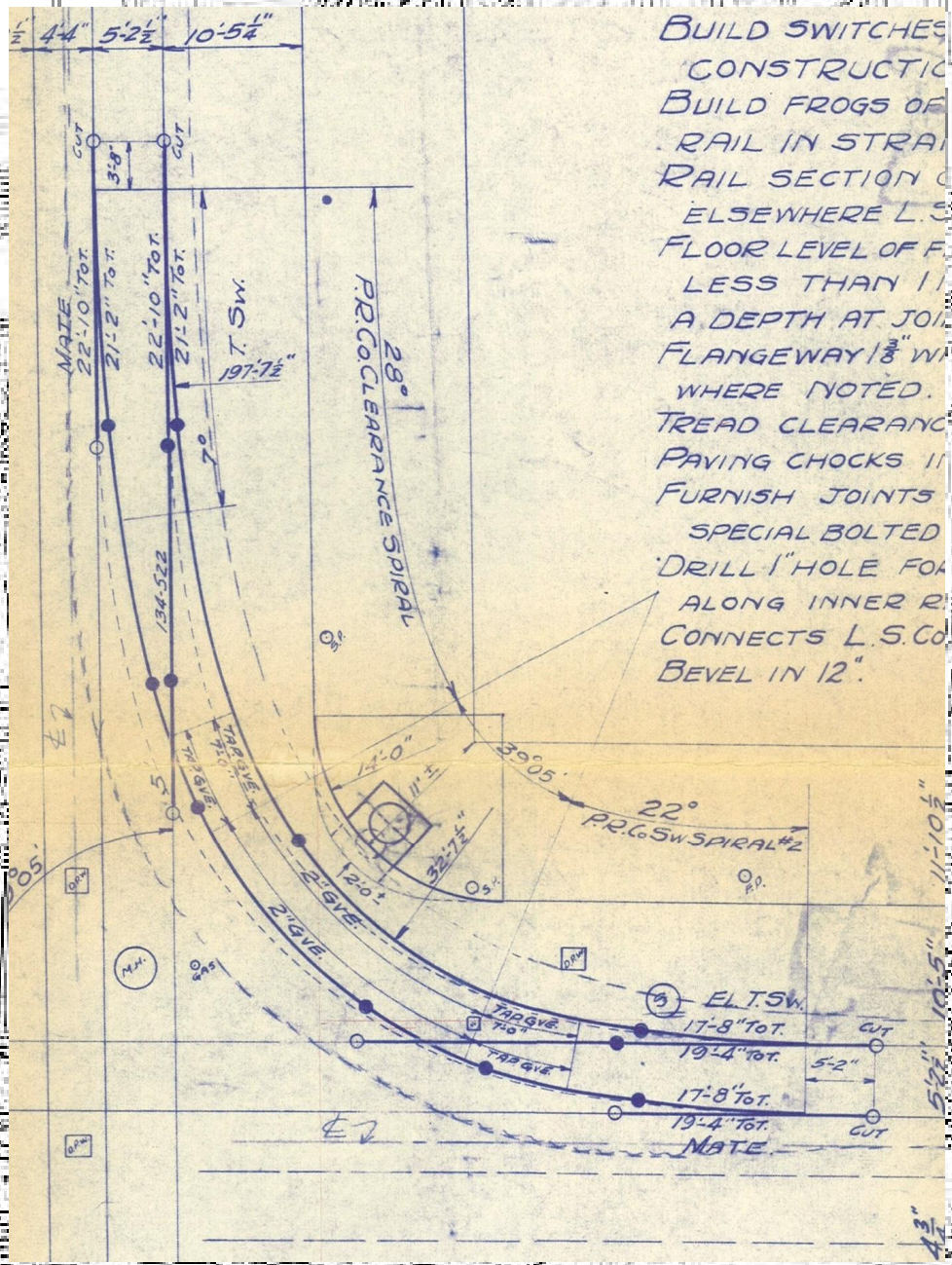
Spirals:

- *To enhance ride comfort, include either spirals or compound transition curves at the ends of any curves regardless of whether or not the track is superelevated.*
- *Spirals can also mitigate clearance issues with circulator "end overhang" when entering and leaving sharp curves.*

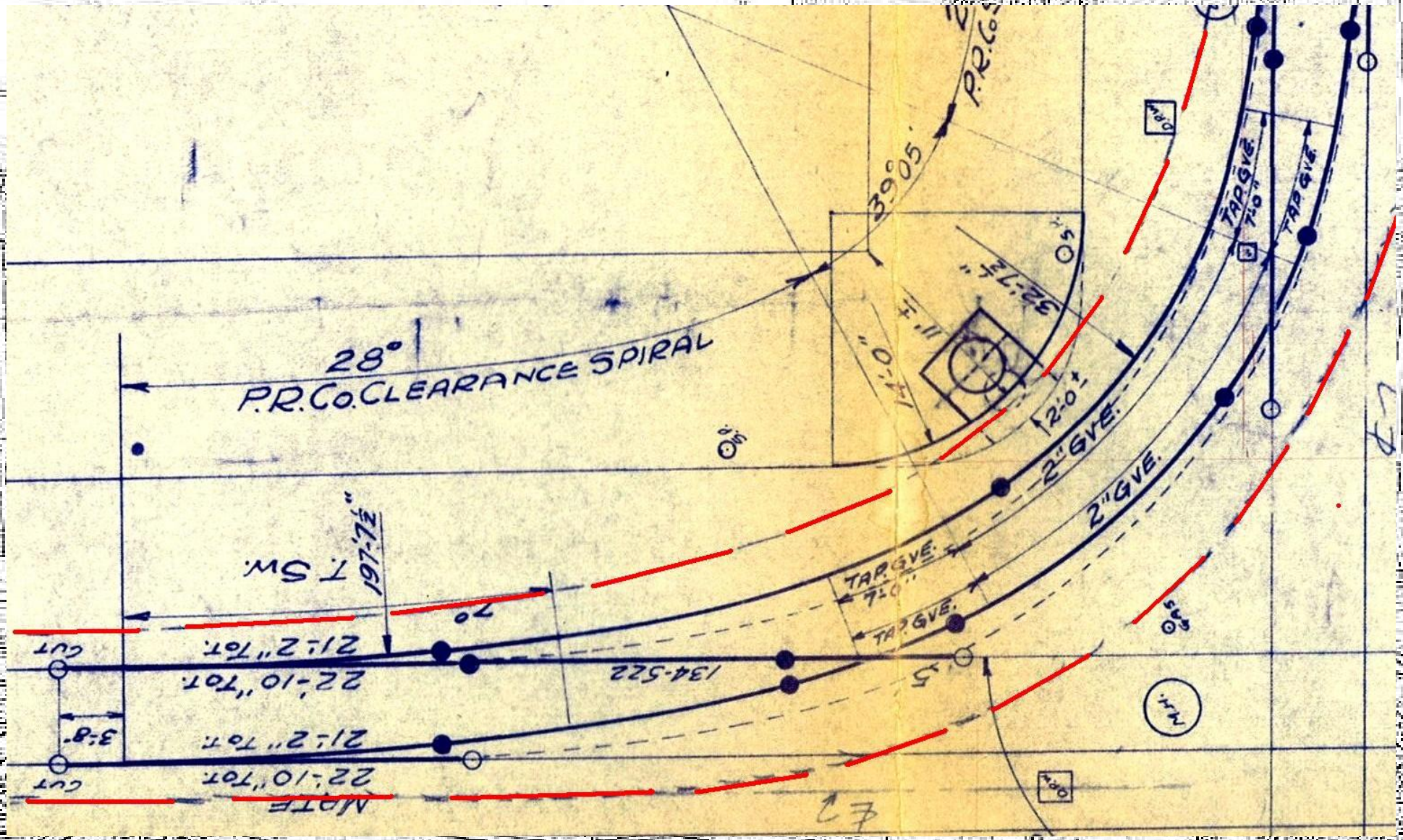
Track Geometry Considerations

GUIDELINE #18

Spirals can also mitigate clearance issues with circulator "end overhang" when entering and leaving sharp curves.



Track Geometry Considerations



Clearance Spirals

Pavement Design Considerations

GUIDELINE #19

Grass Track:

- *Consider long term maintenance issues.*
- *Consider snow removal in northern climates.*
- *Accept that the trackway will invite pedestrian trespass and incorporate mitigation measures in the operating plan.*

End of the line...

For questions concerning this presentation or for further information / assistance contact:

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