ANNEX D
TECHNICAL SPECIFICATIONS FOR THE COMMISSIONING OF THE INFRASTRUCTURE

1 MODE OF COMMISIONING

The Contractor shall request the Contracting Administration to carry out verification of the section rehabilitation. From the date of the request, the Contracting Administration will have 5 days to start inspection, in accordance with the provisions of this Annex and other contractual documents. The Contracting Administration will have 15 business days for inspection, during which it can generate railway traffic to assess the operation and functionality of the infrastructure. The inspections will be performed by the person or persons appointed by the Contracting Administration, who will be accompanied by the representative appointed by the Contractor Corporation.

Verification of tolerances for the execution of the works will be made for each item or separately.

To this end, the Contract Supervisor will define two non-overlapping railway areas for each item or category.

The parties will draw up a report of the proceedings in each inspection carried out.

2 TECHNICAL STANDARDS FOR THE INSPECTION

2.1 Sleepers squaring

It will be visually noted if the sleepers are squared in the entire section to be inspected.

In cases of discrepancy the measurements made will admit a tolerance of up to 1 sexagesimal degree with reference to the normal direction of the track.

2.2 Gauge

The straight gauge must be 1,435 mm. The value of the gauge in a curve shall be specified in the proposal made by the Contractor after redesigning works and in agreement with the Works Supervisor.

Tolerance on the gauge value will be ±2 mm.

The gauge will have a maximum variation of 2 mm in 1 meter and 6 mm in 50 meters. Maximum variation on the gauge value will be ±3 mm.

2.3 Fastenings

It will be verified that 100% of the fasteners are secure and properly located.

2.4 Sleepers compaction

All sleepers placed within the corresponding areas will be inspected.

For compaction, the sound made when the inspected sleeper is hit with a ball cane, will be taken into consideration.

No sleeper may be badly tamped (hollow sound).

2.5 Leveling

2.5.1 Longitudinal leveling

Along the entire length of the areas included in the Certificate of Commissioning, verification of the corresponding level of a row of rails and curves on the low rail will take place, allowing a tolerance of -10 mm and +0 mm from the level indicated in the project.

Variation of the longitudinal leveling between two points is defined as follows:

$vnL = |(p_n - c_n) - (p_{n+1} - c_{n+1})|$, where:

p_n = project level at point n
p_{n+1} = project level at point n+1
c_n = existing level at point n
c_{n+1} = existing level at point n+1

For every pair of points spaced less than 3 meters it must be met that vnL < 4mm.

The curves agreement to link different ground elevations will be done through parables whose curvature (maximum at the top and decreasing toward the tangent points with the straight lines it links) shall respect the following values:

Top train speed (km/h)	Less than 50 km/h	50	60	70	80	90
Radius Recommended (m)	3000	4000	5000	6000	8000	10000
Minimum radius (m)	2000	2000	2500	3000	3500	4000

The minimum length of agreements will be:

L = 2∗R∗D for the valley
L = R∗D for the peaks
Where D = |i1 - i2| (absolute value of the change in slope between the two alignments elevation expressed in ‰ (per thousand)).
L and R values are given in meters.

2.5.2 Cross leveling

For the cant measured every 3 meters, the algebraic differences between the existing cross leveling and that of the project must not exceed +3mm in each of the measurements.

Then, it must be met that:
-3 mm < (bn - an) < +3 mm
where:
an: project unevenness between the two rails at point n.
bn: existing unevenness between the two rails at the same point n.

The cant value of the proposed geometric correction (project) must comply with the following:
where:
h = cant in mm
V = speed in km/h
R = curve radius in meters

The following is defined:

THEORETICAL CANT	: $h = 11.8 \times V^2/R$
NORMAL PRACTICAL CANT	: hp = 2/3 theoretical h
MINIMUM CANT	: $h = 11.8\ V^2/R - 100$

CANT DEFICIENCY = h theoretical – h real (when h theoretical ≥ h real)
CANT EXCESS = h real – h theoretical (when h real ≥ h theoretical)
For the cant deficiency, the theoretical cant is calculated with the maximum design speed; and for the cant excess, the theoretical cant will be calculated with the minimum speed of the project.

Cant limitations are as follows:

MAXIMUM CANT	150 mm
MAXIMUM CANT IN CONVERGENT EXTERIOR CHANGES	120mm
MAXIMUM CANT IN DIVERGENT EXTERIOR CHANGES	90mm
MAXIMUM CANT IN INTERIOR CHANGES	150mm
CANT IN DETOURS AND STATION RAILS	0mm
MAXIMUM CANT DEFICIENCY	100mm
MAXIMUM CANT EXCESS	80mm

2.5.3 Warp

The variation of cant or cross leveling between two consecutive measurements performed (every three meters), must be the same as that indicated in the project, with a tolerance not exceeding ± 2 mm.
So in absolute value it must be met:
$|(b_{n+1} - a_{n+1}) - (b_n - a_n)| \leq 2$ mm

2.5.4 Alignment

There will be a visual appreciation for the alignment quality over the entire length of the track section to be certified and/or received.

The areas to be inspected will be marked every 10m with a 20 m rope. The difference in absolute value between the actual and theoretical arrows used for the marking will be less than or equal to the following tolerances:

in straight track	tolerance: 3 mm
in curved track of radius > 1,500m	tolerance: 3 mm
in curved track of 1,500m > radius > 500m	tolerance: 4 mm
in curved track of radius < 500m	tolerance: 5 mm

The variation between two consecutive arrows will be less than or equal to the following values:

straight line and curve of radius > 1,500 m	5mm
curves of 1,500m > radius > 500 m	6 mm
curves of 1,500m < 500 m	7 mm

All curves should have input and output transitions clothoid type respecting the following values:

NORMAL LENGTH: $L = 9.4\ V \times h$

where: L = length in meters
V = speed in km/h
h = real cant in meters

MINIMUM LENGTH: $L = 6.7\ V \times h$

EXCEPTIONAL MINIMUM LENGTH: L = 5.6 V x h (with authorization from the Contract Supervisor)

OTHER PARAMETERS:

MINIMUM LENGTH OF STRAIGHT LINES: LR = V/2 V in km/h

MINIMUM LENGTH OF CIRCULAR CURVE: LC = V/2
In special cases the Contract Supervisor may authorize the link of two alignments only with transition curves, eliminating the section of the circular curve.

2.6 Supplemented joints

They are not acceptable because rails are new.

2.7 Welding of rails on site. Standard for welding of rails on site

2.7.1 Surface quality of welded joints

After welding and grinding the following must not be noted:

- Porosity and/or other defects in the bond area of molten and laminated metal.
- Defects in the bond of the beam plate and the head of the rail.
- Deep insertions (corundum or vitrified sand) on the head of the rail (in the running surface or vertical surfaces).
- Over the entire surface of molten metal; blowholes, discontinuity or evidence of oxidation and lack of materials for any reason.
- Cavities.

2.7.2 Special requisites

CHARACTERISTICS OF THE WELDED JOINT
Flexural breaking load
After the joint has been made according to specifications, the breaking load shall be greater than 72 tonnes, for rails with tensile strength up to 85 kg/mm^2.

Brinell hardness:
Brinell hardness determined as indicated must not be less than or exceed by more than 30 units with respect to the hardness determined in the rail 200 mm from the weld zone.
Metallographic structure:
Examined the weld zone, the bond between the molten metal and the sheet metal must be metallic, without cracks or other discontinuities.

Porosity:
Prepared the surface to be examined, the cross section of the rail in the joint must not show pores in magnitude that exceeds 5% of the original section of the rail.

Alignment:

Verified the welded joint, the tolerance is 0.5 mm in new or trimmed used rails.
In the other cases, it will depend on the state of the rails to join.

2.7.3 Control of welded joints

Appearance and alignment:
These characteristics will be verified in all welds. In the event that any weld did not meet the requirements, it must be performed again and paid by the Contractor. This involves placing a coupon and making two welds for each defective one.
If the number of welds with defective appearance exceeds 15% of the welds made, the Contracting Administration may terminate the contract with all the consequences for the contractor.

Bending, porosity, Brinell hardness and metallographic structure test:
For every 300 welds in the rails the Contractor will make a welded joint for laboratory testing, using coupon rails intended for this purpose.

The welds may be made on site or in the workshop, in the presence of the Contracting Administration and Contractor representatives.
In addition, every 1,000 welds made on the rails, the Contract Supervisor will extract two to be tested.
In case any test fails to comply with the provisions of these specifications, two additional tests will be conducted for each rejection. If any of the tests does not give a satisfactory result, the Contracting Administration may terminate the work and the contract with the corresponding consequences for the Contractor.

2.7.4 Flexural breaking load test methods

The test is done by subjecting the coupons welded to bending under the following conditions:

a) Distance between supports: 1 meter.
b) Load application and support wedge shape: Cylindrical diameter 30 to 50 mm.

The rail is arranged so that its foot is subjected to tensile stress. The load application must be in correspondence with the welding.

Breaking loads are recorded and, if necessary, the arrows as well.

2.7.5 Brinell hardness

The test is performed in the rail head running surface in the center of the welded joint and at 10, 20, 40 and 200 mm on each side.

In case used rails have been utilized, the surface where hardness is determined must be previously brushed 3 mm deep.
10 mm metal balls and 3,000 kg load are used.

2.7.6 Porosity

A saw cut is made in the cross section of the rail, in the joint area to check if there are pores.

2.7.7 Metallographic structure

A cut is made in the joint area, in the rail longitudinal direction. The section obtained is prepared for metallographic observation.

2.7.8 Alignment

A meter-long metal ruler is put on the head of the rail, placed with its center in correspondence with the welding, determining the alignment in the horizontal and vertical directions.

2.8 Track switchers

The new track switcher will be commissioned when: alignment, leveling, ballast compaction, gauge and drains in the area are suitable for train traffic, without speed restrictions due to railway conditions.

The values and tolerances or maximum discrepancies between the actual geometry after placing the track switcher and the theoretical ones defined in the project are the following:

- track gauge (1435mm): + 0mm and -2mm
- throat between vertexes (59mm): +1.5mm and -2mm
- wheel flangeway (43mm): 1mm and -1mm
- check rail throat (38mm): ± 2mm
- safety headroom (1396mm): ± 2mm
- alignment: $|\text{theoretical arrow - real arrow}| \leq 2\text{mm}$ for a 20m rope
- Cross leveling: $|\text{theoretical cant - real cant}| \leq 3\text{mm}$ for any of the cross sections considered
- Longitudinal leveling: $|\text{project headroom - real headroom}| \leq 5\text{mm}$
- warp: the absolute difference in the existing cross leveling between any two parts separated less than 20 meters shall not exceed 4 mm for all points considered and, the difference in absolute value between any two real headrooms separated by less than 10m, may not exceed 10% of the value specified in the project.

All sleepers must be well settled on the ballast and to check them a ball cane will be used.

2.9 Tolerance in bridges

In addition to the tolerances specified in the preceding paragraphs, the following will be in force:

- track gauge: ±2mm from the gauge defined in the project.

- fitting sleeper: -2 mm < h(i) - h'(i) < +2 mm

where:

h(i): height of the i-th projected fitting sleeper in the median vertical plane of the rail supporting beam.
h'(i): height of the i-th real fitting sleeper in the median vertical plane of the rail supporting beam.

- rail fastened to the sleeper: the same as the railway settled on ballast, but the area will be all the bridge.
- sleeper fastened to the beam supporting rail: each bolt will be tightened to the maximum torque that the sleeper and rail supporting beam allow, without damaging the sleeper, beam, bolt and washers.

- Longitudinal leveling: -3 mm < c(i) - c'(i) < +3mm

where:

c(i): projected rail headroom when examining the i-th sleeper
c'(i): real rail headroom when examining the i-th sleeper

- warp: the absolute difference between the cross unevenness on the rail measured in any two successive bridge sleepers, may not exceed 3 mm.

Cross level and alignment: the same as the railway settled on ballast, except that the area to be examined will be the entire bridge.

To accept the work on the track section examined, compliance with all tolerances at every point of the bridge is required.

3 COMMISSIONING

In the event that any of the areas inspected does not comply with the required tolerances, commissioning will not be accepted.

The Contractor shall correct all defects detected in the inspected area and recheck the entire section to correct any other possible defects.

Once the correction task is finished, the Contract Supervisor will select two different areas from those previously chosen. Tolerances for all parameters in these new areas will be checked and if all of them are within tolerance, the section will be accepted.

In the event that any of the areas inspected does not comply with the required tolerances, commissioning will not be accepted.

In the latter case the Contract Supervisor will have to check all the parameters throughout the section and have all defects found corrected.

The Contractor shall pay all costs the Contract Supervisor may have to verify and correct the defects found.

Once the Contracting Administration has verified to its satisfaction the railway conditions, it will have 2 working days to issue the infrastructure Certificate of Commissioning. The Contractor Corporation will be paid the first day after the Certificate of Commissioning has been issued.