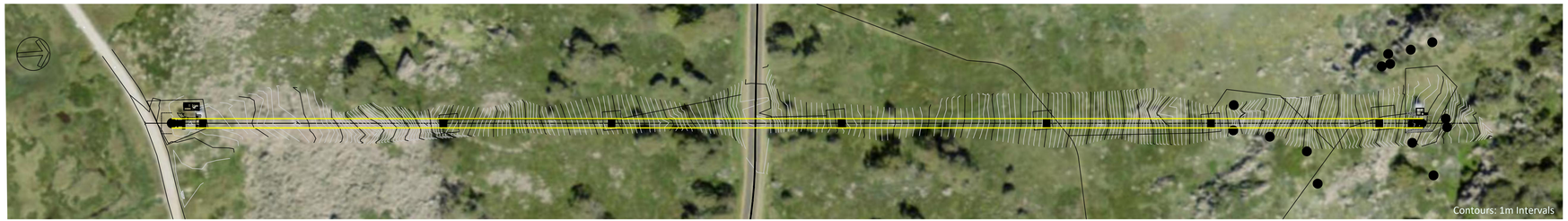
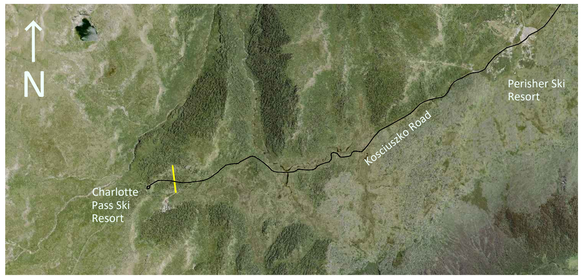
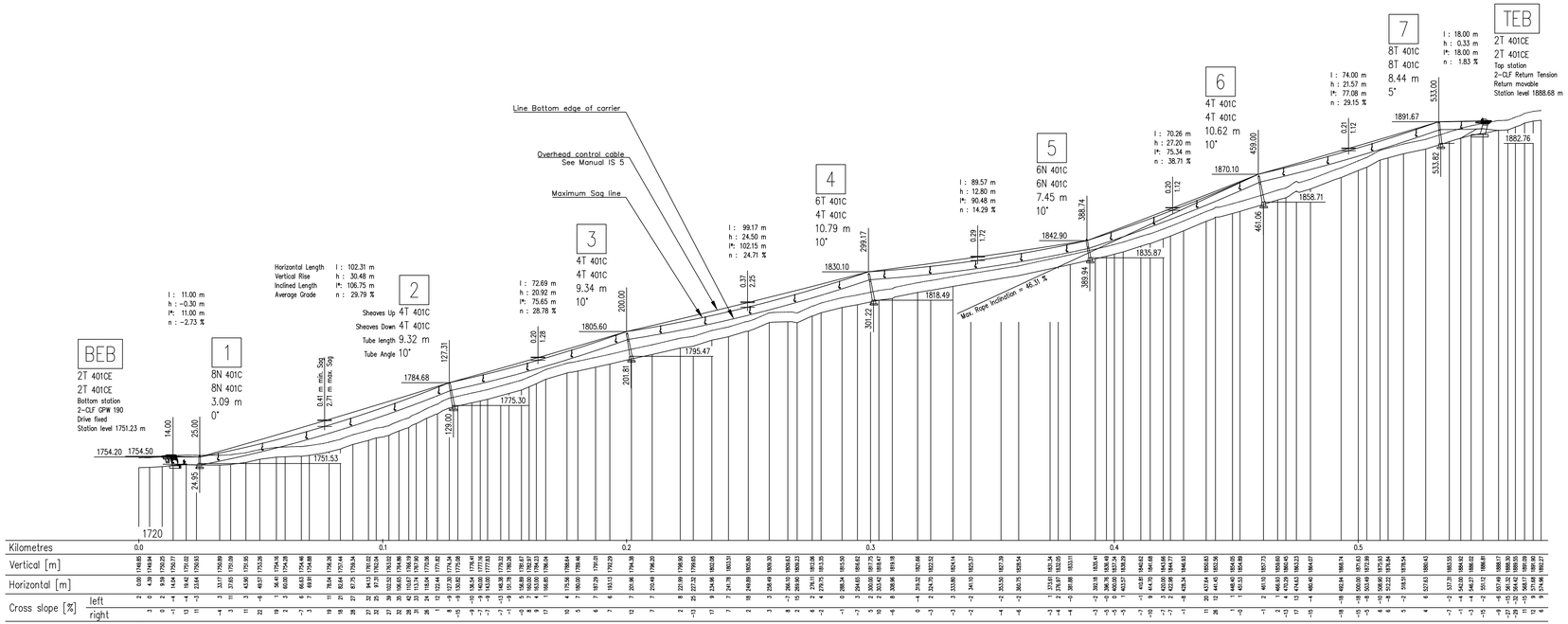


Guthries 2-CLF Aerial View



Guthries 2-CLF Locality Plan



Guthries 2-CLF Profile View

Profile origin:
Profile file: Guthries ground points 20200623.gel
Ropeway file: Guthries 20200623.clf
Program: Seiba 1.68.2 CIN:1593062973

Profile
2-CLF Guthries

Customer: Charlote Pass
Location: Charlotte Pass

Technical Data:

Uphill Side	Left	ϕ Haul Rope	32 mm
Drive Station	Bottom	Minimum Breaking Strength	652 kN
Tension Station	Top	ϕ Drive Bullwheel	4.00 m
Return Station	Top	ϕ Return Bullwheel	3.00 m
Horizontal Length	537.00 m	Rope Gauge on Line	4.00 m
Vertical Rise	137.50 m	Drive Output Continuous	55 kW
Average Grade	25.61 %	Drive Output Starting (0.15 m/s²)	74 kW
Max. Rope Inclination	46.31 %	Elevation of Drive Station	1754 m
Inclined Length	556.45 m	Uphill Transportation	100 %
Spliced Rope Length	1133.20 m	Downhill Transportation	50 %

	Initial	Final
Drive Speed	2.50 m/s	2.50 m/s
Capacity	635 pph	953 pph
Number of Carriers	40	60
Carrier Spacing	28.33 m	18.89 m
Carrier Interval	11.33 s	7.55 s
Trip Time	3.86 min	3.86 min

Index	Revision	Date	Name
A	Updated tower 2, tower 4 location	2021-03-15	SHT

Doppelmayr

Drawn	20201001 SHT
Approved	
Scale	1:1000
Project No.	2020-15
Drawing No.	2020-15-P-001
Index	A

Project [-No]: 2-CLF Guthries [2020-15]

Rope line calculation

2-CLF Guthries

Project number:

2020-15

Profile number:

2020-15-P-001

created:	20201001	SHT
vis.:	.....	.....

Project [-No]: 2-CLF Guthries [2020-15]

Contents

Project [-No]: 2-CLF Guthries [2020-15]

Symbols and abbreviations

Ao	Suspension above
Au	Suspension below
BW	Bullwheel
c	Inclined length
D	Tower load (resulting force in the rope point)
DCG	Distance CTF to ground
DS	Load per sheave
EB	Entrance beam
f	Sag
F2	Distance sheave assembly main axle - rope point
fy	Horizontal rope deflection
h	Elevation difference
HA	Suspension height of sheave assembly
HC	Distance bottom of yoke to bottom of connection plate
HG	Grout (distance bottom of shaft to CTF)
HS	Shaft length
HY	Yoke height
IO	In operation
l	Horizontal length
LcF	Load case ropeway
OO	Out of operation
Q	Cross inclination
q	Wind load
r	Rope radius
RP	Rope point
S0	Basic tensioning force
T	Rope tension
T0-	Basic tension force with undertension
T0+	Basic tension force with overtension
W	Wind
WS	Wind load per sheave
XA,ZA	Coordinates of sheave assembly main axle
XF,ZF	Coordinates CTF
XR,ZR	Rope point coordinates
α	Deflection angle
γ	Span inclination
ε	Tower angle
φ	Rope angle
φh	Horizontal lead-on/lead-off angle
ψ	Tower load reaction angle

Project [-No]: 2-CLF Guthries [2020-15]

Main data

Installation location:	Charlotte Pass
Client:	Charlote Pass
Installation type:	2-CLF
Direction of rotation:	clockwise
Uphill side:	left
Uphill capacity:	100 %
Downhill capacity:	50 %
Parking location:	---
Drive:	Bottom
Tension location:	Top
Tensioning type:	Hydraulic tensioning
Tensioning force:	240.00 kN
Basic tensioning force:	120.00 kN
Regulation:	CAN/CSA-Z98-07 Passenger Ropeways, 2007 <modified>
Haul rope:	32 mm 6x25 FW 1770 Fatzer
Carrier:	2 E Doppelmayr FG2A
Number of carriers:	60
Spacing:	18.89 m

Geometrical data

Horizontal length:	537.00 m
Vertical rise:	137.70 m
Average grade:	25.64 %
Inclined length:	556.50 m
Transportation length:	579.68 m
Spliced rope length:	1133.30 m
Gauge:	4.00 m

Speed/Capacity

Main drive:	Rope speed:	2.50 m/s (backwards: -1.00 m/s)
	Capacity:	952 Persons/h
	Interval:	7.56 s
	Trip time:	3.86 min
Evac drive:	Rope speed:	1.00 m/s
	Capacity:	380 Persons/h
	Interval:	18.89 s
	Trip time:	9.66 min

Project [-No]: 2-CLF Guthries [2020-15]

Carrier - Chair

Manufacturer:	Doppelmayr
Type:	2 E
Dead weight:	85 kg
Pay load:	154 kg (2 Persons)
Total weight:	239 kg
Length (L):	1.00 m
Dist. CL rope to top of seat (HS):	2.72 m
Dist. CL rope to bottom of carrier (H0):	2.90 m
Dist. CL rope to bottom of carrier (Hmax):	3.22 m
Projection area empty, perpendicular:	0.35 m² (cf: 1.30)
Projection area loaded, perpendicular:	0.60 m² (cf: 1.30)
Side swing 0.00 rad: Yi0 / Yo0:	0.72 / 0.63 m
Side swing 0.20 rad: Yi20 / Yo20:	1.13 / 1.05 m
Side swing 0.34 rad: Yi34 / Yo34:	1.61 / 1.53 m
Grip:	FG2A
Grip slipping force:	6.4 kN

Haul rope data

Manufacturer:	Fatzer
Rope construction:	6x25 FW
Diameter:	32.0 mm
Diameter outer wire:	2.00 mm
Metallic area:	423.00 mm²
Rope weight:	3.73 kg/m
Tensile strength:	1770 N/mm²
Calculated breaking strength:	748 kN
Minimum breaking strength:	652 kN
Elastic modulus:	100 kN/mm²
Thermal expansion factor:	1.20E-05 1/K
Permanent elongation:	1.50 ‰
Spliced rope length:	1133.30 m
Order length:	1202 m (incl. splice length: 38 m; surcharge 30 m; reserve: 0 m)

Icing

ice density:	0.600 kg/dm³
ice thickness haul rope:	30 mm

Sheaves

Sheave	Side plate diameter	Base of Groove diameter
401C.1	408 mm	382 mm

Project [-No]: 2-CLF Guthries [2020-15]

Stations

Bottom station

Type:	2-CLF GPW 190 mit Betonsteher fixed
Entrance beam (EB):	XR: 14.00 m ZR: 1754.50 m
Gauge at entrance beam:	4.00 m
Rope angle at entrance beam:	0.00 °
Distance EB to loading/unloading:	11.18 m
Rope length in station:	11.18 m
Drive bullwheel:	D = 4.00 m; I = 5500 kgm²; α = 180.00 °
Tmax:	129 kN (Lc: 1+)
Tmin:	82 kN (Lc: 7-)

Top station

Type:	2-CLF Return Tension Return movable mit Betonsteher
Entrance beam (EB):	XR: 551.00 m ZR: 1892.20 m
Gauge at entrance beam:	3.00 m
Rope angle at entrance beam:	0.00 °
Distance EB to loading/unloading:	12.00 m
Rope length in station:	9.11 m
Return bullwheel:	D = 3.00 m; I = 1420 kgm²
Tmax:	130 kN (Lc: 4+)
Tmin:	110 kN (Lc: 7-)

Project [-No]: 2-CLF Guthries [2020-15]

Main drive

Total inertia:	9.20 kgm²
Acceleration:	0.15 m/s²
Deceleration:	-0.30 m/s²

Gearbox

Manufacturer:	Doppelmayr-Lohmann
Type:	GPW 190 III S
Nominal torque:	98.0 kNm
Max. torque:	137.2 kNm
Ratio:	107.89
Efficiency:	0.93
Inertia:	0.50 kgm²
Req. input speed:	1288 U/min
Utilisation:	42 %
Req. torque continuous:	41.2 kNm (Lc: 100% UH Load, 0% DH Load; Forward operation (2.5m/s); T0+; IO)
Req. torque maximum:	47.3 kNm (Lc: 100% UH Load, 0% DH Load; Starting (0.15m/s²); T0+; IO)

Electric motor

Manufacturer:	ABB
Type:	280LAB
Rating:	181 kW
Speed:	1480 U/min
Inertia:	2.70 kgm²
Req. power continuous:	55 kW (Lc: 100% UH Load, 0% DH Load; Forward operation (2.5m/s); T0+; IO)
Req. power starting:	74 kW (Lc: 100% UH Load, 0% DH Load; Starting (0.15m/s²); T0+; IO)
Req. power braking:	-28 kW (Lc: 0% UH Load, 100% DH Load; Braking (-0.30m/s²); T0-; IO)

Service brake

Inertia:	6.00 kgm²
Max. braking torque:	1.26 kNm (4.14 kN @ 0.61 m)
Req. braking torque:	0.31 kNm (Lc: 100% UH Load, 0% DH Load; Reverse Braking (-0.30m/s²); T0; IO)

Emergency brake

Max. braking torque:	82.5 kNm (50.00 kN @ 3.30 m)
Req. braking torque:	33.2 kNm (Lc: 100% UH Load, 0% DH Load; Reverse Braking (-0.30m/s²); T0; IO)

Evac drive

System:	V-belts hydraulic
Diesel engine:	Cummins B3.9-C/130 (Pn=90kW @ 2438m; Pb=27.5kW)
Efficiency:	continuous, starting / braking: 0.80 / 1.00
Req. power continuous:	28 kW (Lc: 100% UH Load, 0% DH Load; Forward operation (1.0m/s); T0+; IO)
Req. power braking:	-1 kW (Lc: 0% UH Load, 100% DH Load; Braking (-0.05m/s²); T0-; IO)
Req. Mdmax bullwheel:	46.6 kNm (Lc: 100% UH Load, 0% DH Load; Starting (0.05m/s²); T0+; IO)

Project [-No]: 2-CLF Guthries [2020-15]

Regulation **CAN/CSA-Z98-07 Passenger Ropeways, 2007 <modified>**

Passenger weight: 77 kg

Mininum acceleration accelerating / braking: **0.15 / -0.30 m/s²**

Minimum shear ratio Carrier / Sheave: 14.0 / ---

Tensioning tolerances: +8.0%; -8.0%

Rope design factor: min.: 4.5 without dynamic
max.: --- without dynamic
Minimum breaking strength

Friction factors: Sheaves: continuous / starting / braking: 2.5% / 2.5% / 2.0%
Bullwheels: 0.30%

Allowable friction values on the drive bullwheel: 0.205

Wind loads:

In operation (IO):	250 N/m²
In operation, rope deflection sideways:	375 N/m²
Out of operation (OO):	1200 N/m²
Out of operation, rope deflection sideways:	1200 N/m²
Out of operation, sheave assemblies:	1000 N/m²

Reduced wind load rope deflection sideways:
$q' = q \cdot \delta^2$; l*<=200m: δ=1.00; l*=900m: δ=0.65; l*>=2000m: δ=0.50

Reduced wind load out of operation TFC:
$q' = q \cdot \beta$; l*<=200m: β=1.00; l*=900m: β=0.65; l*>=2000m: β=0.50

Aerodynamic force coefficients: Rope: 1.20 Ice: 1.20

Vertical deviation of the ropes: Variations of the extreme sag: ---

Min. required distance between passing carriers, both swung 0.20 rad inward: 1.00 m

consider lateral deviation of ropes: maximum horizontal rope deflection (fymax)

Min. bullwheel diameter: 72-times rope diameter 800-times outer wire diameter

Min. required sheave load: 500+50(d-(D1-D2)) N Support: 500 N Hold-down: 500 N

Min. required load per sheave assem2000 N
0.0 kN on support towers considering local tension force increase of 30%
0.0 kN on hold-down towers considering a local tension force decrease of 30% and a simultaneaus increase of pay load of 0%

0.8 * max. lateral wind force (in operation) onto adjacent spans
1.0 * max. lateral wind force (out of operation) onto adjacent spans

Max. permissible deflection angle per sheave: 0.08 rad

Safety distance: Maximum chord gradient: 0.01 rad

Clearance envelope, req. line width: transversal carrier sway: 0.34 rad
safety distance IO / OO: 1.50 / 1.50 m

Max. centripetal acceleration on passing tower: 2.00 m/s²

(bold: modified)

Project [-No]: 2-CLF Guthries [2020-15]

Tower geometry

Tower	XF [m]	ZF [m]	DCG [m]	HS [m]	ε [°]	HG [mm]
B						
1	24.95	1751.53	0.61	3.09	0.0	50.00
2	127.00	1774.90	0.68	9.32	10.0	40.00
3	201.81	1795.47	1.12	9.34	10.0	40.00
4	301.22	1818.49	0.48	10.79	10.0	40.00
5	389.95	1835.85	0.94	7.45	10.0	50.00
6	464.97	1860.11	1.14	10.62	10.0	40.00
7	533.82	1882.86	0.47	8.44	5.0	40.00
T						

Project [-No]: 2-CLF Guthries [2020-15]

Rope point coordinates — UH

Rope point	XR [m]	ZR [m]	ψ [°]	α [°]	F2 [m]
BEB	14.00	1754.50	-1.1	2.3	-0.23
1	25.00	1754.20	5.8	14.5	-0.53
2	125.31	1784.28	17.0	5.4	0.33
3	200.00	1805.60	14.3	6.5	0.34
4	299.17	1830.10	10.9	10.4	0.39
5	388.74	1842.90	14.5	8.5	-0.41
6	462.91	1871.50	18.4	8.3	0.35
7	533.00	1891.80	9.0	16.9	0.51
TEB	551.00	1892.20	1.0	2.0	-0.23

Rope point coordinates — DH

Rope point	XR [m]	ZR [m]	ψ [°]	α [°]	F2 [m]
BEB	14.00	1754.50	-1.0	2.1	-0.23
1	25.01	1754.19	6.3	15.7	-0.54
2	125.31	1784.27	16.4	4.1	0.32
3	200.00	1805.58	14.5	5.4	0.32
4	299.18	1830.07	10.9	9.2	0.35
5	388.74	1842.89	14.6	9.6	-0.42
6	462.91	1871.50	18.5	7.6	0.34
7	533.00	1891.79	9.0	16.5	0.50
TEB	551.00	1892.20	0.9	1.8	-0.23

Project [-No]: 2-CLF Guthries [2020-15]

Span geometry — UH

Span	l [m]	h [m]	c [m]	γ [°]	γ [%]
BEB — 1	11.00	-0.30	11.00	-1.56	-2.73
1 — 2	100.31	30.08	104.72	16.69	29.98
2 — 3	74.69	21.32	77.68	15.93	28.55
3 — 4	99.17	24.50	102.15	13.88	24.71
4 — 5	89.57	12.80	90.48	8.13	14.29
5 — 6	74.17	28.60	79.49	21.09	38.56
6 — 7	70.09	20.30	72.97	16.15	28.96
7 — TEB	18.00	0.40	18.00	1.27	2.22

Span geometry — DH

Span	l [m]	h [m]	c [m]	γ [°]	γ [%]
BEB — 1	11.01	-0.31	11.01	-1.62	-2.84
1 — 2	100.31	30.08	104.72	16.69	29.99
2 — 3	74.69	21.31	77.67	15.93	28.53
3 — 4	99.17	24.49	102.15	13.87	24.69
4 — 5	89.57	12.82	90.48	8.15	14.32
5 — 6	74.17	28.61	79.49	21.09	38.57
6 — 7	70.09	20.30	72.97	16.15	28.96
7 — TEB	18.00	0.41	18.00	1.29	2.25

Project [-No]: 2-CLF Guthries [2020-15]

Calculation mode and load configurations

Calculation method: Point load, increments of 0.19 m

Calculated load cases

1	Rope Only; Forward operation (2.5m/s); T0; IO
1+	Rope Only; Forward operation (2.5m/s); T0+; IO
1-	Rope Only; Forward operation (2.5m/s); T0-; IO
2	Rope + Empty Carriers; Forward operation (2.5m/s); T0; IO
2+	Rope + Empty Carriers; Forward operation (2.5m/s); T0+; IO
2-	Rope + Empty Carriers; Forward operation (2.5m/s); T0-; IO
3	Rope + Empty Carriers; Standstill; T0; OO
3+	Rope + Empty Carriers; Standstill; T0+; OO
3-	Rope + Empty Carriers; Standstill; T0-; OO
4	100% UH+DH Load; Forward operation (2.5m/s); T0; IO
4+	100% UH+DH Load; Forward operation (2.5m/s); T0+; IO
4-	100% UH+DH Load; Forward operation (2.5m/s); T0-; IO
5	100% UH Load, 0% DH Load; Forward operation (2.5m/s); T0; IO
5+	100% UH Load, 0% DH Load; Forward operation (2.5m/s); T0+; IO
5-	100% UH Load, 0% DH Load; Forward operation (2.5m/s); T0-; IO
6	Rope + Empty Carriers, 1 Span 100% Load; Forward operation (2.5m/s); T0; IO
6+	Rope + Empty Carriers, 1 Span 100% Load; Forward operation (2.5m/s); T0+; IO
6-	Rope + Empty Carriers, 1 Span 100% Load; Forward operation (2.5m/s); T0-; IO
7	100% UH+DH Load; Starting (0.15m/s²); T0; IO
7+	100% UH+DH Load; Starting (0.15m/s²); T0+; IO
7-	100% UH+DH Load; Starting (0.15m/s²); T0-; IO
8	100% UH Load, 0% DH Load; Starting (0.15m/s²); T0; IO
8+	100% UH Load, 0% DH Load; Starting (0.15m/s²); T0+; IO
8-	100% UH Load, 0% DH Load; Starting (0.15m/s²); T0-; IO
9	0% UH Load, 100% DH Load; Braking (-0.30m/s²); T0; IO
9+	0% UH Load, 100% DH Load; Braking (-0.30m/s²); T0+; IO
9-	0% UH Load, 100% DH Load; Braking (-0.30m/s²); T0-; IO

Project [-No]: 2-CLF Guthries [2020-15]

Rope tension extremes, rope design factors, shear ratio

Rope tension extremes	Tmax (SSP; Bz)	Tmin (SSP; Bz)
Values at nominal tension without dynamics	121.3 kN (7; 4)	93.2 kN (BBW; 4)
Values at nominal tension with dynamics	121.4 kN (7; 7)	91.8 kN (BBW; 7)
extremes without dynamics	131.0 kN (7; 4+)	83.8 kN (BBW; 4-)
extremes with dynamics	131.1 kN (7; 7+)	82.5 kN (BBW; 7-)

Rope design factor: min.: 4.98 max.: 7.78

Minimum shear ratio carrier: 35.77

Specific weights:
- rope only: 0.0366 kN/m
- rope + empty carriers: 0.0807 kN/m
- rope + loaded carriers UH: 0.1607 kN/m
- rope + loaded carriers DH: 0.1207 kN/m

Greatest rope inclination: 46.50 %; 24.94 ° (RP: 6; Lc: 7-)

Max. rope angle change: 0.0646 rad; 3.70 ° (RP: 1)

Required min. pull force: 2.96 kN

Bullwheel - ΣTmax and Mdmax, extreme values with dynamic

	ΣTmax [kN]	(Lc)	Md [kNm]	Mdmax [kNm]	(Lc)	ΣT [kN]	pmax [N/mm²]	(Lc)
Drive bullwheel	249.3	(1+)	17.9	47.3	(8+)	225.7	2.9	(1+)
Return bullwheel	259.2	(1+)					4.0	(1+)

Bullwheel - ΣTmax and Mdmax, values at nominal tension without dynamic

	ΣTmax [kN]	(Lc)	Md [kNm]	Mdmax [kNm]	(Lc)	ΣT [kN]
Drive bullwheel	230.0	(1)	16.6	40.0	(5)	207.1
Return bullwheel	240.0	(1)				

Clearance envelope

req. line width: 12.12 m
req. line width — UH — left: 6.06 m (RP: 1; Lc: 3-)
req. line width — DH — right: 6.06 m (RP: 1; Lc: 3-)

Project [-No]: 2-CLF Guthries [2020-15]

Maximum and minimum rope tensions — UH

Rope point	Tmax [kN]	(Lc)	Tmin [kN]	(Lc)
BBW	120.54	(1+)	82.47	(7-)
BEB	120.62	(1+)	82.47	(7-)
1	121.52	(1+)	82.54	(7-)
2	122.74	(1+)	87.69	(7-)
3	123.72	(1+)	91.54	(7-)
4	125.01	(1+)	96.51	(7-)
5	126.11	(1+)	99.09	(7-)
6	128.14	(3+)	104.77	(7-)
7	129.59	(3+)	108.91	(7-)
TEB	129.60	(3+)	109.94	(7-)
TBW	129.60	(3+)	110.07	(1-)

Maximum and minimum rope tensions — DH

Rope point	Tmax [kN]	(Lc)	Tmin [kN]	(Lc)
BBW	128.72	(1+)	94.63	(9-)
BEB	128.72	(1+)	94.58	(9-)
1	128.61	(1+)	94.11	(9-)
2	128.74	(1+)	97.65	(9-)
3	129.40	(1+)	100.14	(9-)
4	130.10	(1+)	103.29	(9-)
5	130.15	(1+)	104.67	(9-)
6	130.54	(1+)	108.53	(9-)
7	131.05	(7+)	110.36	(3-)
TEB	130.11	(4+)	110.40	(3-)
TBW	129.99	(1+)	110.40	(3-)

Project [-No]: 2-CLF Guthries [2020-15]

Maximum and minimum rope angles — UH

Rope point	φ1max [°]	(Lc)	φ1min [°]	(Lc)	Δφ1 [°]	φ2max [°]	(Lc)	φ2min [°]	(Lc)	Δφ2 [°]
BEB	0.00	(1)	0.00	(1)	0.00	-3.29	(7-)	-1.66	(1+)	1.63
1	-1.47	(1+)	0.18	(7-)	1.65	15.83	(1+)	10.35	(7-)	5.48
2	22.68	(7-)	17.55	(1+)	5.13	15.30	(1+)	11.31	(7-)	3.99
3	20.36	(7-)	16.57	(1+)	3.80	13.04	(1+)	8.21	(7-)	4.83
4	19.28	(7-)	14.71	(1+)	4.57	7.38	(1+)	3.24	(7-)	4.15
5	12.95	(7-)	8.88	(1+)	4.07	20.47	(1+)	17.00	(7-)	3.47
6	24.94	(7-)	21.70	(1+)	3.24	15.58	(1+)	12.48	(7-)	3.10
7	19.71	(7-)	16.73	(1+)	2.99	1.13	(3+)	-0.12	(7-)	1.25
TEB	2.66	(7-)	1.42	(3+)	1.24	0.00	(1)	0.00	(1)	0.00

Maximum and minimum rope angles — DH

Rope point	φ1max [°]	(Lc)	φ1min [°]	(Lc)	Δφ1 [°]	φ2max [°]	(Lc)	φ2min [°]	(Lc)	Δφ2 [°]
BEB	0.00	(1)	0.00	(1)	0.00	-2.70	(9-)	-1.71	(1+)	0.98
1	-1.54	(1+)	-0.56	(9-)	0.98	15.87	(1+)	12.54	(9-)	3.33
2	20.69	(9-)	17.51	(1+)	3.18	15.32	(1+)	12.84	(9-)	2.47
3	18.93	(9-)	16.53	(1+)	2.40	13.06	(1+)	10.01	(9-)	3.05
4	17.61	(9-)	14.67	(1+)	2.94	7.42	(1+)	4.73	(9-)	2.70
5	11.53	(9-)	8.87	(1+)	2.66	20.49	(1+)	18.23	(9-)	2.26
6	23.85	(9-)	21.69	(1+)	2.16	15.59	(1+)	13.52	(9-)	2.07
7	18.73	(9-)	16.71	(1+)	2.02	1.15	(1+)	0.30	(9-)	0.84
TEB	2.28	(9-)	1.44	(5+)	0.84	0.00	(1)	0.00	(1)	0.00

Project [-No]: 2-CLF Guthries [2020-15]

Maximum and minimum rope sags, min. rope radii — UH

Span	c [m]	fmax [m]	(Lc)	Tm [kN]	fmin [m]	(Lc)	Tm [kN]	fmin2 [m]	(Lc)	rmin [m]
BEB — 1	11.00	0.08	(7-)	83.10	0.00	(1+)	120.62	0.00	(3+)	180
1 — 2	104.72	2.61	(7-)	85.72	0.41	(1+)	122.07	0.92	(3+)	549
2 — 3	77.68	1.35	(7-)	90.43	0.22	(1+)	123.13	0.50	(3+)	581
3 — 4	102.15	2.25	(7-)	95.25	0.38	(1+)	124.16	0.85	(3+)	599
4 — 5	90.48	1.72	(7-)	98.92	0.30	(1+)	125.24	0.65	(3+)	604
5 — 6	79.49	1.25	(7-)	102.21	0.23	(1+)	126.64	0.50	(3+)	676
6 — 7	72.97	1.01	(7-)	107.60	0.19	(1+)	127.87	0.42	(3+)	689
7 — TEB	18.00	0.11	(7-)	109.91	0.01	(3+)	129.59	0.01	(3+)	373

Maximum and minimum rope sags, min. rope radii — DH

Span	c [m]	fmax [m]	(Lc)	Tm [kN]	fmin [m]	(Lc)	Tm [kN]	fmin2 [m]	(Lc)	rmin [m]
BEB — 1	11.01	0.05	(9-)	94.95	0.00	(1+)	128.61	0.00	(8+)	296
1 — 2	104.72	1.75	(9-)	96.30	0.39	(1+)	128.19	0.89	(8+)	821
2 — 3	77.67	0.92	(9-)	99.49	0.21	(1+)	129.01	0.48	(8+)	851
3 — 4	102.15	1.56	(9-)	102.57	0.37	(1+)	129.65	0.82	(8+)	859
4 — 5	90.48	1.21	(9-)	104.64	0.29	(1+)	129.92	0.64	(8+)	852
5 — 6	79.49	0.90	(9-)	107.32	0.22	(1+)	130.02	0.49	(8+)	940
6 — 7	72.97	0.74	(9-)	110.22	0.19	(1+)	130.57	0.41	(8+)	940
7 — TEB	18.00	0.08	(9-)	110.74	0.01	(7+)	130.07	0.01	(7+)	521

Project [-No]: 2-CLF Guthries [2020-15]

Maximum horizontal rope deflection, lead-on angle — UH

Span	c [m]	qIO [kN/m²]	fyIO [m]	(Lc)	φhIO [°]	qOO [kN/m²]	fyOO [m]	(Lc)
BEB — 1	11.00	0.375	0.01	(7-)	0.26	1.200	0.02	(3-)
1 — 2	104.72	0.375	0.48	(7-)	1.06	1.200	1.03	(3-)
2 — 3	77.68	0.375	0.25	(7-)	0.74	1.200	0.55	(3-)
3 — 4	102.15	0.375	0.42	(7-)	0.93	1.200	0.95	(3-)
4 — 5	90.48	0.375	0.32	(7-)	0.80	1.200	0.74	(3-)
5 — 6	79.49	0.375	0.23	(7-)	0.67	1.200	0.55	(3-)
6 — 7	72.97	0.375	0.19	(7-)	0.59	1.200	0.46	(3-)
7 — TEB	18.00	0.375	0.01	(7-)	0.07	1.200	0.02	(3-)

Maximum horizontal rope deflection, lead-on angle — DH

Span	c [m]	qIO [kN/m²]	fyIO [m]	(Lc)	φhIO [°]	qOO [kN/m²]	fyOO [m]	(Lc)
BEB — 1	11.01	0.375	0.01	(9-)	0.22	1.200	0.02	(3-)
1 — 2	104.72	0.375	0.43	(9-)	0.94	1.200	1.03	(3-)
2 — 3	77.67	0.375	0.23	(9-)	0.67	1.200	0.55	(3-)
3 — 4	102.15	0.375	0.39	(9-)	0.87	1.200	0.95	(3-)
4 — 5	90.48	0.375	0.30	(9-)	0.76	1.200	0.74	(3-)
5 — 6	79.49	0.375	0.22	(9-)	0.64	1.200	0.55	(3-)
6 — 7	72.97	0.375	0.18	(9-)	0.57	1.200	0.46	(3-)
7 — TEB	18.00	0.375	0.01	(9-)	0.07	1.200	0.02	(3-)

Project [-No]: 2-CLF Guthries [2020-15]

Bz: Rope + Empty Carriers; Forward operation; T0; IO — UH

Rope point	Tmax [kN]	Tmin [kN]	Dmax [kN]	Dmin [kN]	fmax [m]	fmin [m]
BEB	105.14	104.79	3.88	3.06	0.03	0.01
1	105.83	104.85	-29.19	-28.80	1.05	1.03
2	108.55	107.87	8.53	8.48	0.56	0.56
3	110.52	109.77	10.99	10.95	0.96	0.94
4	112.88	112.14	18.94	18.86	0.75	0.72
5	114.39	113.55	-19.23	-19.10	0.56	0.55
6	117.24	116.57	15.91	15.84	0.46	0.46
7	119.55	118.65	34.43	34.36	0.04	0.01
TEB	119.64	119.54	3.82	2.99	0.00	0.00

Bz: Rope + Empty Carriers; Forward operation; T0; IO — DH

Rope point	Tmax [kN]	Tmin [kN]	Dmax [kN]	Dmin [kN]	fmax [m]	fmin [m]
BEB	113.05	112.70	4.23	3.40	0.02	0.00
1	112.93	111.90	-31.54	-31.14	0.99	0.97
2	114.67	114.00	8.63	8.58	0.53	0.53
3	116.15	115.41	11.20	11.15	0.92	0.90
4	117.75	117.02	19.38	19.30	0.72	0.69
5	118.30	117.46	-20.09	-19.96	0.54	0.54
6	120.25	119.60	16.19	16.11	0.45	0.45
7	121.29	120.41	34.83	34.76	0.04	0.01
TEB	120.46	120.36	3.87	3.04	0.00	0.00

Project [-No]: 2-CLF Guthries [2020-15]

Brake calculations (2.0% sheave friction factor)

Service brake

Load case:	100% UH Load, 0% DH Load; Reverse Braking; T0; IO	
Braking deceleration:	-0.30 m/s²	
Required braking moment:	0.31 kNm	
Available braking moment:	1.26 kNm	(4.14 kN @ 0.61 m)
Adjusted braking moment:	0.31 kNm	(Factor control reserve: 1.00)

Emergency brake

Load case:	100% UH Load, 0% DH Load; Reverse Braking; T0; IO	
Braking deceleration:	-0.30 m/s²	
Required braking moment:	33.23 kNm	
Available braking moment:	82.50 kNm	(50.00 kN @ 3.30 m)
Adjusted braking moment:	33.23 kNm	(Factor control reserve: 1.00)

Braking deceleration

Simultaneous operation of service brake and emergency brake
Braking moment, operatively: 66.46 kNm

Braking deceleration	Load case	µReq
-0.68 m/s²	100% UH Load, 0% DH Load; Reverse Braking; T0; IO	0.044
-0.85 m/s²	0% UH Load, 100% DH Load; Braking; T0; IO	0.027
-1.03 m/s²	Rope + Empty Carriers; Braking; T0; IO	0.009

Max. braking deceleration

Simultaneous operation of service brake and emergency brake incl. control reserve
Braking moment, operatively: 66.46 kNm

Braking deceleration		Load case	µReq
max.:	-1.18 m/s²	100% UH Load, 0% DH Load; Braking; T0; IO	0.007

Inertia calculations

	Moments of inertia (reduced to the drive bullwheel)	Moved masses (reduced to haul rope)
Haul rope data	16909 kgm²	4227 kg
Bullwheels	8024 kgm²	2006 kg
Sheaves	4998 kgm²	1249 kg
Carriers	20400 kgm²	5100 kg
Payload (per side)	18480 kgm²	4620 kg
Main drive	107090 kgm²	26773 kg

Coasting deceleration (2.0% sheave friction factor)

Coasting deceleration		Load case
max.:	0.42 m/s²	100% UH Load, 0% DH Load; Forward operation; T0; IO
	0.20 m/s²	Rope Only; Forward operation; T0; IO
	0.18 m/s²	Rope + Empty Carriers; Forward operation; T0; IO

Project [-No]: 2-CLF Guthries [2020-15]

Comparison of actual, calculated values with required values from regulations

	(Lc)	(RP)	Actual		Limit
Min. Rope design factor	(4+)	(7)	4.98	≥	4.50
Minimum shear ratio carrier	(4-)		35.77	≥	14.00
Ratio bullwheel diameter / rope diameter			94	≥	72
Ratio bullwheel diameter / rope diameter outer wire			1500	≥	800
Min. gauge	(7-)	(1)	4.00 m	≥	3.74 m
Max. rope deflection angle per sheave	(9-)	(4)	0.053 rad	≤	0.078 rad
Max. centripetal acceleration on passing towers	(4)	(4)	0.58 m/s²	≤	2.00 m/s²
Min. tower load ratios	(8-)	(BEB)	1.53	≥	1.00
Min. sheave load ratio, min. sheave load	(8-)	(BEB)	1.23 kN	≥	0.80 kN
Min. load per sheave	(7-)	(5)	1.54 kN	≥	0.80 kN
Min. load per sheave assembly	(1-)	(2)	4.58 kN	≥	2.00 kN
Min. load on support sheave assembly at local T+	(1-)	(2)	4.99 kN	≥	0.00 kN
Min. load on hold down sheave assembly at local T-	(7-)	(5)	-1.52 kN	≤	0.00 kN
Min. ratio tower load to wind load IO	(1-)	(2)	5.23	≥	0.80
Min. ratio tower load to wind load OO	(3-)	(2)	1.23	≥	1.00
Friction coefficient at the drive sheave	(5-)		0.066	≤	0.205
Friction coefficient at the drive sheave with dynamic	(8-)		0.073	≤	0.205
Grip pulling force			6.40 kN	≥	2.96 kN
Min. carrier interval			7.56 s	≥	6.00 s
Min. braking deceleration			0.30 m/s²	≥	0.30 m/s²
Max. braking deceleration			1.18 m/s²	≤	2.50 m/s²
Available operating travel			2.50 m	≥	0.31 m
Available tension carriage travel			2.50 m	≥	1.57 m

Project [-No]: 2-CLF Guthries [2020-15]

Comparison of actual, calculated values with certified conformity of use

	(Lc)	(RP)	Actual		Limit
Grip pulling force			6.40 kN	≥	2.96 kN