General

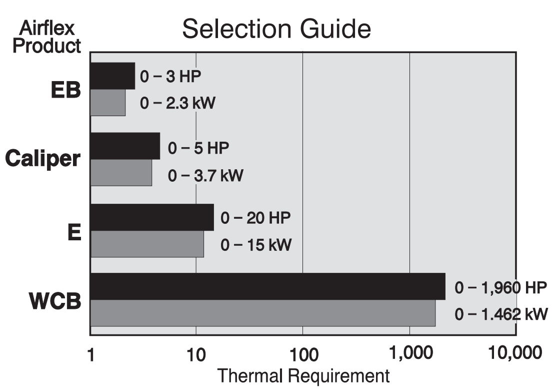
Winding is the process of taking up a web or a strand of a long length of material onto a beam, a cone, a core, a drum or a spool; primarily for handling convenience for end use or reprocessing. Depending upon the industry, the process is also called coiling or spooling. Examples are a roll of paper toweling and a coil of steel providing material in a stamping operation.

Unwinding is the process of controlled payoff of material which has previously been wound, coiled or spooled.

In both processes it is important to maintain a constant tension or pull on the material. Improper tensioning during winding results in roll dishing or telescoping and improper roll density. Improper tensioning during unwinding can cause web distortion and flutter, affecting the reprocessing operation. Material tension can be controlled electrically, hydraulically or mechanically. Airflex products recommended for mechanical (friction) control include the types E, EB, WCB and caliper elements. See selection guide, below.

Material Tension

As indicated, correct tension is important; however, most users are unaware of the material tension required. Tension values may vary considerably from plant to plant and from machine to machine; operator preference as to tightness of web and desired roll densities are also factors. To assist in this matter, the tension charts shown are intended to serve only as a guide.



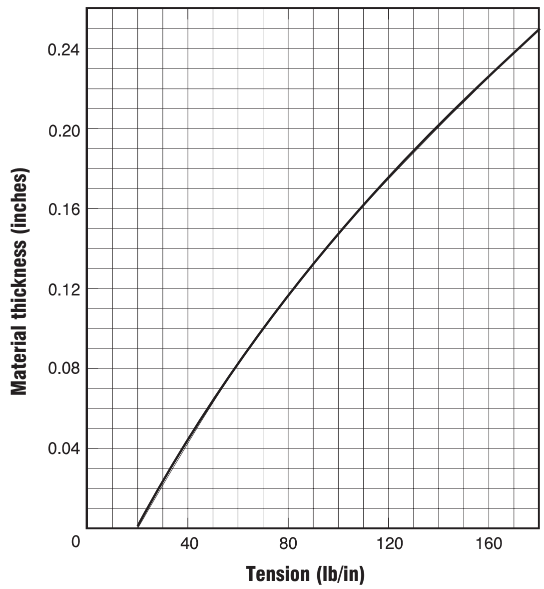
Metal Tension Guide

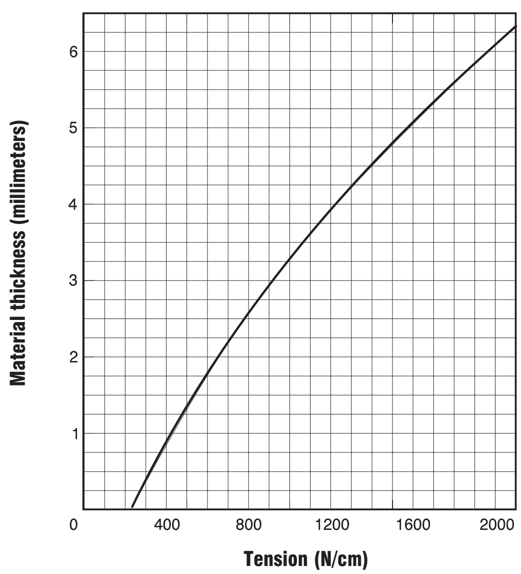
Depending upon material, multiply the graph tension by the following factors:

Aluminum, full hardness	1.00
Aluminum, half hardness	0.75
Brass, full hardness	1.00
Brass, half hardness	0.75

Steel:

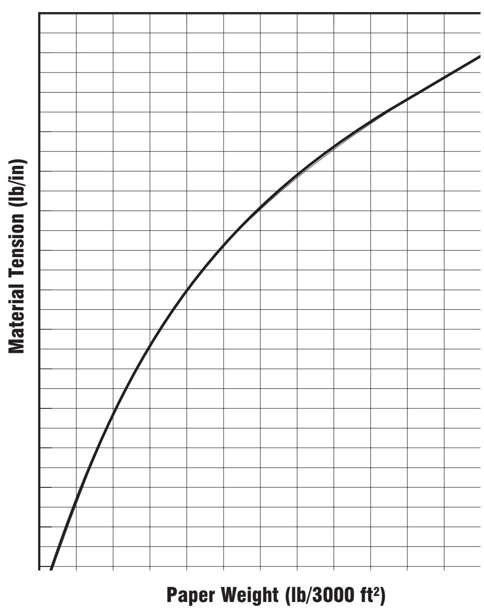
Carbon, fullhardness	2.25
Mild	1.00
Nickel	2.50
Silicon	1.20
Stainless, cold drawn	4.25

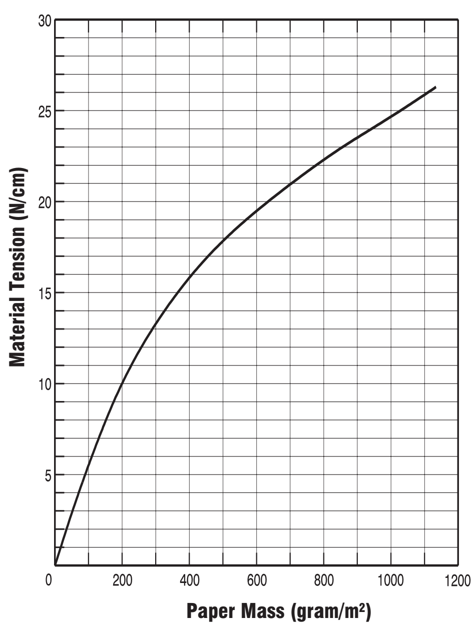




Paper and Board Tension Guide

The paper and board chart is for 3000 ft² (279 m²) of material which is the equivalent of 500 sheets (Ream) 24 in x 36 in (0.62 x 0.91 m). Various papers and board stocks with different basic weight and size designations should be adjusted to 3000 ft² for direct reading from the chart. For example, if a board is designated 120 lbs per 1000 ft², multiply 120 by 3 to bring it to 3000 ft². If board weight is in points, multiply by 10 (i.e., 50 point board x 10 = 500 lbs per 3000 ft²). For chip board multiply the point designation by 8.5.





Slip Clutches and Tension Brakes

In most winding and unwinding applications, in addition to a constant tension, the material processing procedure requires a constant web speed that is usually controlled by the processing machine's main drive. During unwinding, as the roll diameter decreases, the roll rpm increases and the tension or drag brake torque requirement decreases.

When winding, as the roll diameter increases, the roll rpm decreases and the slip clutch torque requirement increases.

Both clutch and brake torque is adjusted by regulation of the applied pressure during the winding and unwinding procedure.

Selection Procedure

In many cases, the winding and unwinding machines are required to handle different types of materials and/or operate under different parameters. It is important to determine the maximum and minimum operating ranges The following parameters are necessary to determine proper clutch and brake sizes (see Section Y for units):

Material

T_{max}: maximum material tension

T_{min}: minimum material tension

or

F_{max}: maximum material pull

F_{min}: minimum material pull

D: maximum roll diameter

d: minimum roll or core diameter

w_{max}: maximum web width

w_{min}: minimum web width

v_{max}: maximum web speed

v_{min}: minimum web speed

R: reduction between clutch or brake shaft and roll shaft

Using the parameters, the following calculations are made:

$$F_{max} = T_{max} \cdot w_{max}$$

$$F_{min} = T_{min} \cdot w_{min}$$

$$M_{max} = F_{max} \cdot 0.5\ D/R$$

$$M_{min} = F_{min} \cdot 0.5\ d/R$$

English Units:

$$N_{max} = \frac{v_{max} \cdot R}{0.262 \cdot d}$$

$$N_{min} = \frac{v_{min} \cdot R}{0.262 \cdot D}$$

SI Units:

$$n_{max} = \frac{v_{max} \cdot R}{5{,}236\ E - 05 \cdot d}$$

$$n_{min} = \frac{v_{min} \cdot R}{5{,}236\ E - 05 \cdot D}$$

For a tension or drag brake on an unwind stand, the thermal power to be dissipated $\mathbf{P_{tb}}$ is

$$P_{tb} = \frac{F_{max} \cdot V_{max}}{33000}\ (HP)$$

$$P_{tb} = \frac{F_{max} \cdot V_{max}}{60000}\ (kW)$$

For a slip clutch on a winding stand, it is desirable to have the driving side of the clutch rotating at a slightly faster speed than the driven side to prevent clutch lockup and a slip-grab situation. The recommended driving speed is 10% greater than the driven speed for speeds under 100rpm and 5% greater for speeds over 100 rpm. Slip clutch thermal power to be dissipated $\mathbf{P_{tc}}$ is:

$$P_{tc} = \frac{M_{max} \cdot n_s}{63025}\ (HP)$$

$$P_{tc} = \frac{M_{max} \cdot n_s}{9550}\ (kW)$$

n_s: slip rpm $= (1.10 \text{ or } 1.05) \cdot n_{max} - n_{min}$

The calculated torques, thermal power and speeds must fall within the capacities given in the appropriate product catalog section.

Type E slip clutch arrangements are shown in Section C on catalog Forms E605 through E607. Air-cooled tension brake arrangements are shown on catalog Forms E608 and E609; water-cooled arrangement on Form E610.

The caliper tension brake arrangement is shown in Section H, Form CA1003.

Water-cooled WCB tension brakes are shown in Section I.

Application examples appear on the following page.

Example

A slip clutch is required for a rewind stand operating under the following conditions:

Material pull F_{max}: 125 lb

Maximum coil diameter D: 20 in

Minimum core diameter d: 12 in

Web speed v_{max}: 1000 fpm

Reduction R: 1:1

$$M_{max} = F_{max} \cdot 0.5 \cdot D = 125 \cdot 0.5 \cdot 20 = 1250 \text{ lb·in}$$

$$M_{min} = F_{max} \cdot 0.5 \cdot d = 125 \cdot 0.5 \cdot 12 = 750 \text{ lb·in}$$

$$n_{max} = \frac{V_{max}}{0.262 \cdot d} = \frac{1000}{0.262 \cdot 12} = 318 \text{ rpm}$$

recommended driving speed=1.05 · 318=334 rpm

$$n_{min} = \frac{V_{min}}{0.262 \cdot D} = \frac{1000}{0.262 \cdot 20} = 190 \text{ rpm}$$

$$n_s = 334 - 190 = 144 \text{ rpm}$$

$$P_t = \frac{M_{max} \cdot n_s}{63025} = \frac{1250 \cdot 144}{63025} = 2.9 \text{ HP}$$

From P_t curves for 3 HP @ 334 rpm select 14E475

$$\text{Approximate operating pressure} = \frac{1250}{16000} \cdot 75 \sim 6 \text{ psi}$$

Example

A tension brake is required to handle the following requirement:

Material tension T_{max}: 18 lb/in

Material tension T_{min}: 18 lb/in

Maximum roll diameter D: 108 in

Core diameter d: 16 in

Maximum web width w_{max}: 216 in

Minimum web width w_{min}: 216 in

Maximum web speed v_{max}: 4100 fpm

Minimum web speed v_{min}: 4100 fpm

Reduction R: 1:1

$$F_{max} = F_{min} = T_{max} \cdot W_{max} = 18 \cdot 216 = 3890 \text{ lb}$$

$$M_{max} = F_{max} \cdot 0.5 \cdot D = 3890 \cdot 0.5 \cdot 108 = 210000 \text{ lb·in}$$

$$M_{min} = F_{min} \cdot 0.5 \cdot d = 3890 \cdot 0.5 \cdot 16 = 31100 \text{ lb·in}$$

$$n_{max} = \frac{V_{max}}{0.262 \cdot d} = \frac{4100}{0.262 \cdot 16} = 978 \text{ rpm}$$

$$n_{min} = \frac{V_{min}}{0.262 \cdot D} = \frac{4100}{0.262 \cdot 108} = 145 \text{ rpm}$$

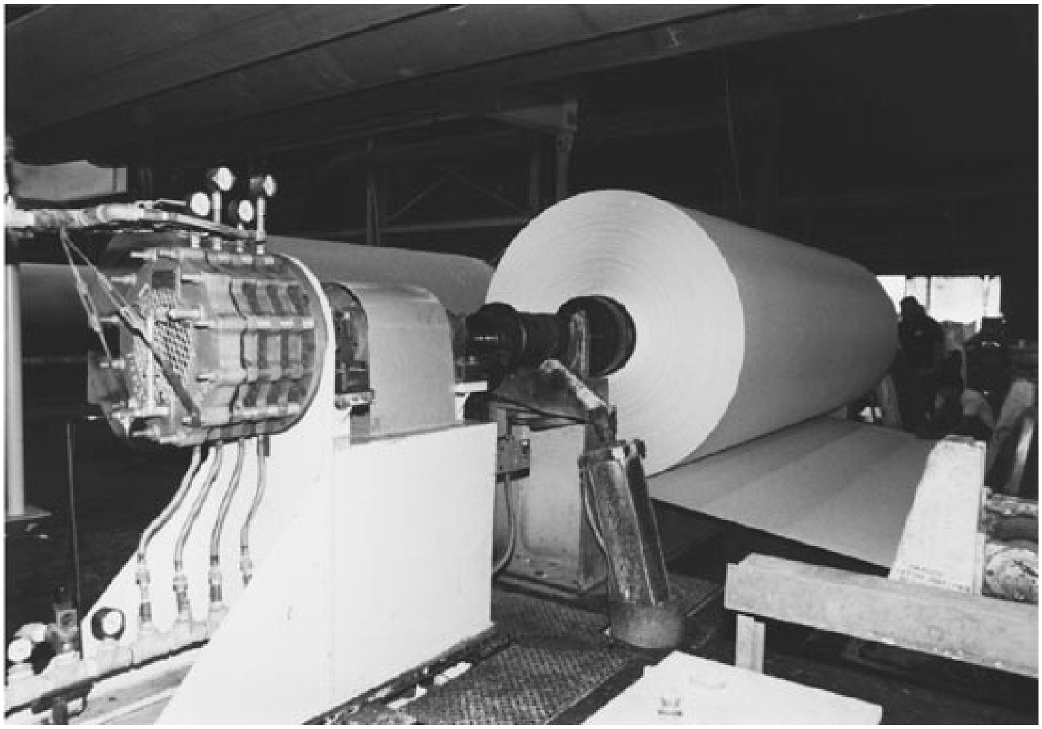
$$P_{tb} = \frac{F_{max} \cdot v_{max}}{33000} = \frac{3890 \cdot 4100}{33000} = 483 \text{ HP}$$

Select 324 WCB

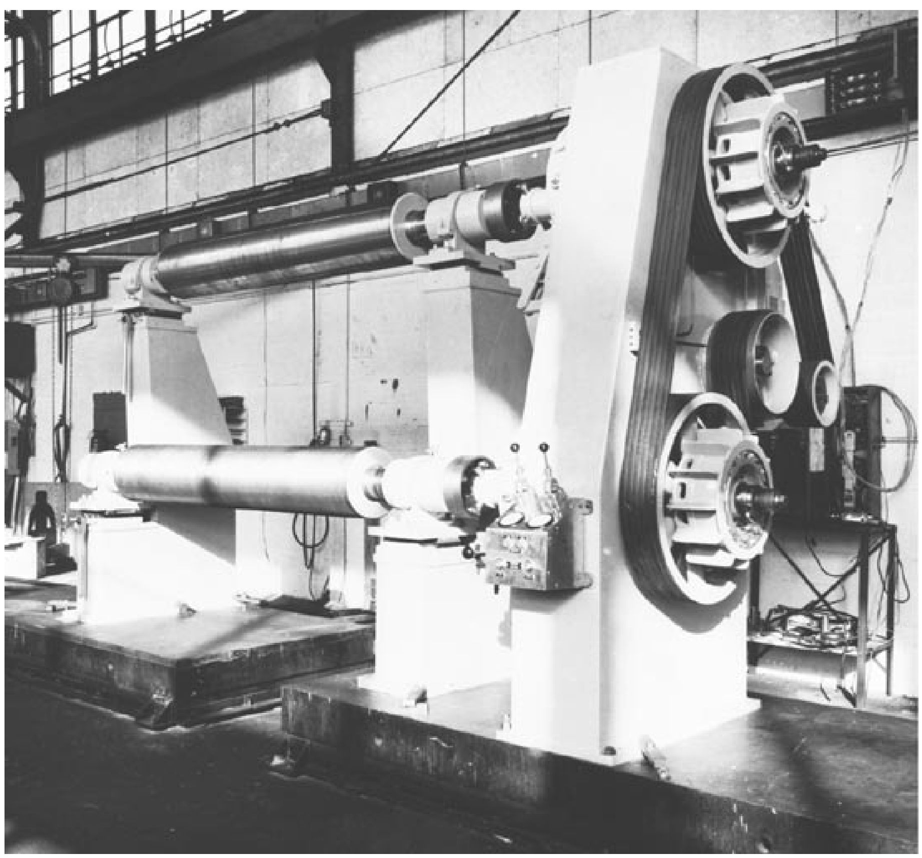
Operating pressure:

$$P_{max} = \frac{M_{max}}{M_r} \cdot p_r = \frac{210000}{300000} \cdot 80 = 56 \text{ psi}$$

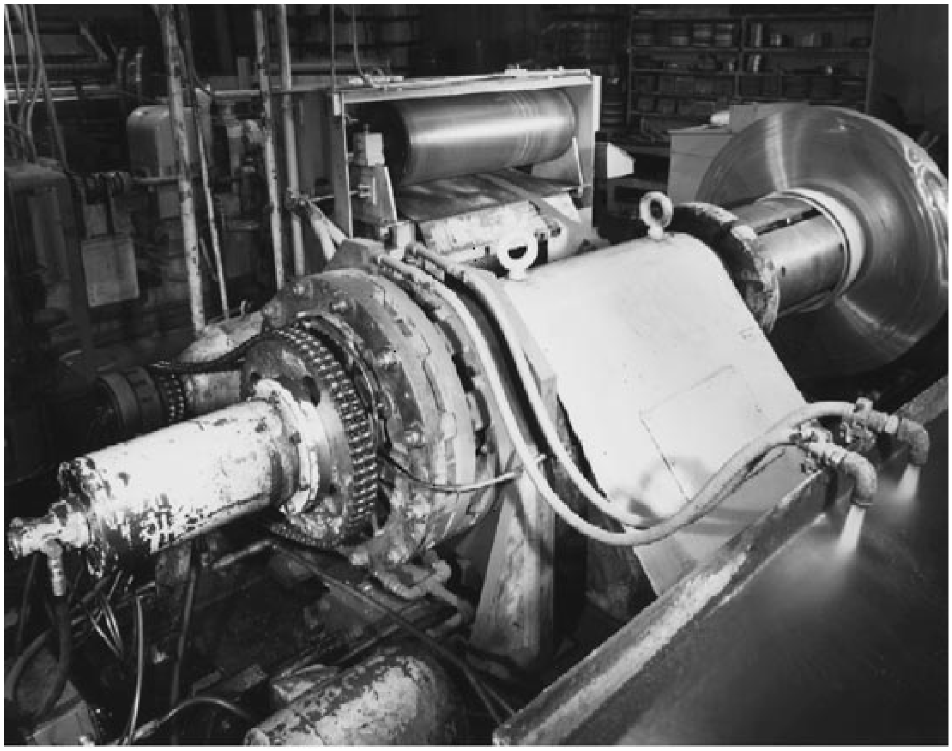
$$P_{min} = \frac{M_{min}}{M_r} \cdot p_r = \frac{31100}{30000} \cdot 80 = 8 \text{ psi}$$



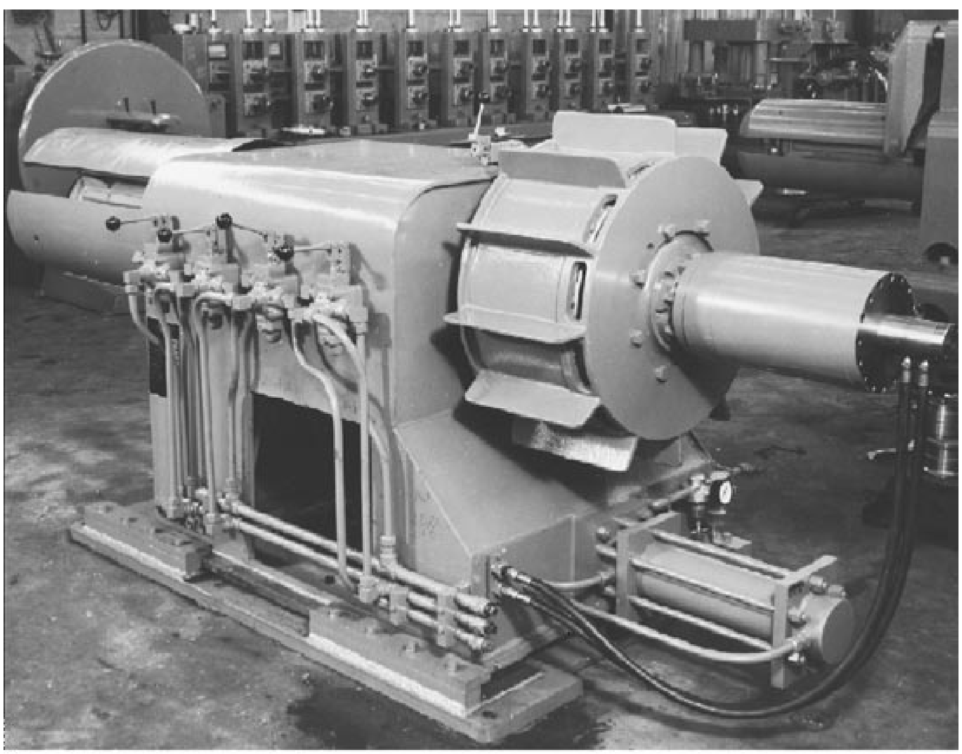
318WCB tension brake on paper unwind stand
65 lb paper (30 kg), 178 inch (4,5 m) @ 5500 fpm (25,4 mps).

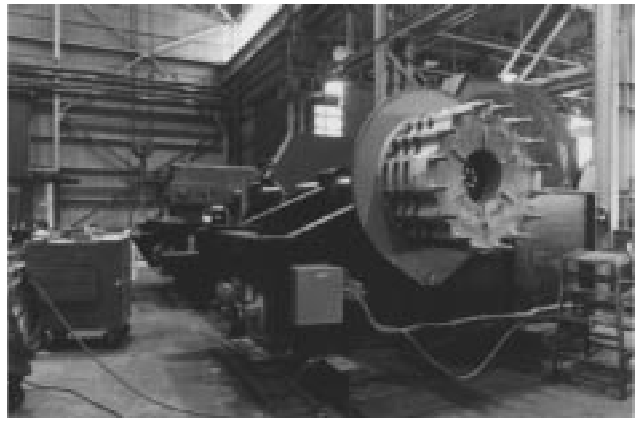


14E475 slip clutches on paper reel stand.

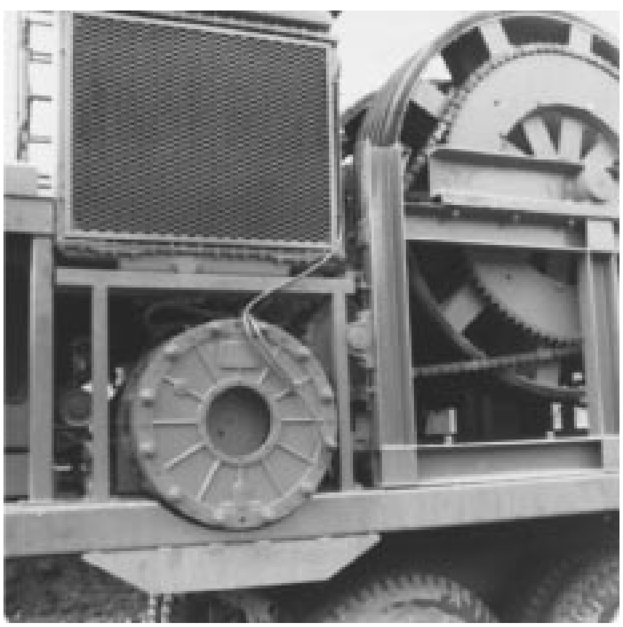


Two metal unwind stands. The stand above employs a 124WCB tension brake, the stand below a dual 16E475 tension brake.





WCB tension brake on an anchor windlass used in the mooring system for offshore floating platforms.



224WCB and 42VC650 tension brakes on power cable stringing equipment.

Power yarders used in logging control tension in cable riggings allowing harvested logs to be raised clear of ground obstacles and hauled back to a gathering area. WCB brakes are applied to main, haulback, skyline and slack pulling drums of the yarders.