



**NATIONAL COMMISSION FOR THE
CERTIFICATION OF CRANE OPERATORS (NCCCO)**

RIGGER REFERENCE BOOKLET

This Reference Booklet has been produced and adapted from various manufacturer's data and is for use in NCCCO written examinations.

This Reference Booklet is not to be used for any other purpose.

This page intentionally left blank

Sling Capacities

Mechanical Splice in pounds

①

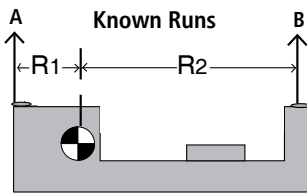
| | Size in inches | | | | | | |
|--------------------|----------------|--------|--------|--------|--------|--------|--------|
| Wire Rope EIPS/WRC | 1/4 | 1,300 | 960 | 2,600 | 2,200 | 1,820 | 1,300 |
| | 5/16 | 2,000 | 1,480 | 4,000 | 3,400 | 2,800 | 2,000 |
| | 3/8 | 2,800 | 2,200 | 5,600 | 5,000 | 4,000 | 2,800 |
| | 7/16 | 3,800 | 2,800 | 7,600 | 6,800 | 5,400 | 3,800 |
| | 1/2 | 5,000 | 3,800 | 10,000 | 8,800 | 7,200 | 5,000 |
| | 9/16 | 6,400 | 4,800 | 12,800 | 11,000 | 9,000 | 6,400 |
| | 5/8 | 7,800 | 5,800 | 15,600 | 13,600 | 11,000 | 7,800 |
| | 3/4 | 11,200 | 8,200 | 22,400 | 19,400 | 15,800 | 11,200 |
| | 7/8 | 15,200 | 11,200 | 30,400 | 26,000 | 22,000 | 15,200 |
| | 1 | 19,600 | 14,400 | 39,200 | 34,000 | 28,000 | 19,600 |
| | 1-1/8 | 24,000 | 18,000 | 48,000 | 42,000 | 34,000 | 24,000 |
| 1-1/4 | 30,000 | 22,500 | 60,000 | 52,000 | 42,000 | 30,000 | |
| MULTIPLIER --> | | | | 1.00 | .75 | .60 | |

Sling Length = Total distance between pick points x multiplier

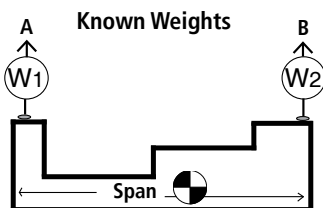
Load Factors & Weight Distribution

②

$$\text{Sling Tension} = \frac{\text{Sling Length (L)}}{\text{Sling Height (H)}} \times \text{share of load wt. } \frac{L}{H}$$



| Share of Load Wt. @ A | Share of Load Wt. @ B | Legend |
|--|--|--|
| $R1 + R2 = TS$ | $R1 + R2 = TS$ | R1 = Run, Side 1 R2 = Run, Side 2 TS = Total Span |
| $\frac{R2}{TS} = P$ | $\frac{R1}{TS} = P$ | P = Percentage |
| $P \times W = \text{Share of Load Wt @ A}$ | $P \times W = \text{Share of Load Wt @ B}$ | W = Weight of Load |



| CG In Feet From A | CG In Feet From B | Legend |
|--|--|--|
| $W1 + W2 = TS$ | $W1 + W2 = TS$ | W1 = Weight at A W2 = Weight at B TS = Total Weight |
| $\frac{W2}{TW} = P$ | $\frac{W1}{TW} = P$ | P = Percentage |
| $P \times S = \text{CG in ft. from A}$ | $P \times S = \text{CG in ft. from B}$ | S = Span |

Level & Incline Planes

③

| Legend | Formulas |
|---|---|
| W = Weight of load | Level: $CF \times W = F$ |
| CF = Coefficient of Friction | Uphill: $[CF \times W \times (R/L)] + [(H/L) \times W] = F$ |
| F = Force required to move load | Downhill: $[CF \times W \times (R/L)] - [(H/L) \times W] = F$ |
| H = Height in feet | |
| R = Run, horizontal distance in feet | |
| L = Length of ramp in feet. | |







Coefficients of Friction [For Estimation Only]

| | | | | | |
|----------------------|-----|-------------------------------|-----|----------------|------|
| Concrete on concrete | .65 | Wood on metal | .30 | Steel on steel | .10 |
| Metal on concrete | .60 | Cast iron on steel | .25 | Load on wheels | .05 |
| Wood on wood | .50 | Continuous lubricated surface | .15 | Load on ice | .01 |
| Wood on concrete | .45 | | | Load on air | .002 |

This Reference Booklet is for testing purposes only.

Sling Capacities (lbs)

4

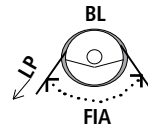
| | Size or Code |  |  |  |  |  |  |
|------------------------|--------------|---|---|---|--|---|---|
| Web Eye / Eye | 1-9-1 | 1,600 | 1,280 | 3,200 | 2,770 | 2,260 | 1,600 |
| | 1-9-2 | 3,200 | 2,560 | 6,400 | 5,540 | 4,452 | 3,200 |
| | 1-9-3 | 4,800 | 3,840 | 9,600 | 8,320 | 6,780 | 4,800 |
| | 1-9-4 | 6,400 | 5,120 | 12,800 | 11,090 | 9,040 | 6,400 |
| | 2-9-3 | 8,880 | 7,100 | 17,760 | 15,390 | 12,540 | 8,880 |
| | 2-9-4 | 11,520 | 9,210 | 23,040 | 19,960 | 16,270 | 11,520 |
| Polyester Round | 1 | 2,600 | 2,100 | 5,200 | 4,500 | 3,600 | 2,600 |
| | 2 | 5,300 | 4,200 | 10,600 | 9,100 | 7,500 | 5,300 |
| | 3 | 8,400 | 6,700 | 16,800 | 14,500 | 11,800 | 8,400 |
| | 4 | 10,600 | 8,500 | 21,200 | 18,300 | 14,900 | 10,600 |
| | 5 | 13,200 | 10,600 | 26,400 | 22,800 | 18,600 | 13,200 |
| | 6 | 16,800 | 13,400 | 33,600 | 29,100 | 23,700 | 16,800 |

Block & Fairlead Loading

5

| Full Included Angle | Block Factor |
|---------------------|--------------|
| 180 | 0.00 |
| 170 | 0.17 |
| 160 | 0.35 |
| 150 | 0.52 |
| 140 | 0.68 |
| 130 | 0.84 |
| 120 | 1.00 |
| 110 | 1.15 |
| 100 | 1.29 |
| 90 | 1.41 |
| 80 | 1.53 |
| 70 | 1.64 |
| 60 | 1.73 |
| 50 | 1.81 |
| 40 | 1.87 |
| 30 | 1.93 |
| 20 | 1.97 |
| 10 | 1.99 |
| 0 | 2.00 |

Example



BL = Block Load
 BF = Block Factor
 LP = Line Pull
 FIA = Full Included Angle

Formula
 BL = BF x LP

Steel Beam Capacities

6

Point load of steel beam



Maximum in lbs.

| Wide flange beams (W in. x F in.) | Maximum in lbs. | |
|--------------------------------------|-----------------|-------------|
| | 10 ft. span | 20 ft. span |
| 4 x 4 | 2,500 | 500 |
| 6 x 4 | 1,100 | 200 |
| 8 x 8 | 13,700 | 3,800 |
| 10 x 4 | 1,200 | 200 |
| 10 x 10 | 20,400 | 10,200 |
| 12 x 8 | 21,100 | 5,800 |
| 12 x 12 | 28,400 | 17,600 |
| 14 x 8 | 25,000 | 6,300 |
| 14 x 10 | 31,300 | 14,300 |
| 16 x 10 | 38,700 | 16,300 |

This Reference Booklet is for testing purposes only.

Rigging Hardware Capacities (lbs)

7

| Size in inches | Shoulder Eye Bolt | | Turnbuckle Eye or Jaw | Master Link | Shackle SP Anchor | Wire Rope Clip | | |
|----------------|-------------------|---------|-----------------------|-------------|-------------------|----------------|--------------------|--------------------|
| | Vertical | 45 Deg. | | | | Min. # clips | Turnback in inches | Torque in ft. lbs. |
| 1/4 | 500 | 125 | 500 | ----- | 1,000 | 2 | 4.75 | 15 |
| 5/16 | 800 | 200 | 800 | ----- | 1,500 | 2 | 5.25 | 30 |
| 3/8 | 1,200 | 300 | 1,200 | ----- | 2,000 | 2 | 6.50 | 45 |
| 7/16 | ----- | ----- | ----- | ----- | 3,000 | 2 | 7.00 | 65 |
| 1/2 | 2,200 | 550 | 2,200 | 4,900 | 4,000 | 3 | 11.50 | 65 |
| 9/16 | ----- | ----- | ----- | ----- | ----- | 3 | 12.00 | 95 |
| 5/8 | 3,500 | 875 | 3,500 | 6,600 | 6,500 | 3 | 12.00 | 95 |
| 3/4 | 5,200 | 1,300 | 5,200 | 10,320 | 9,500 | 4 | 18.00 | 130 |
| 7/8 | 7,200 | 1,800 | 7,200 | ----- | 13,000 | 4 | 19.00 | 225 |
| 1 | 10,000 | 2,500 | 10,000 | 24,360 | 17,000 | 5 | 26.00 | 225 |
| 1-1/8 | ----- | ----- | ----- | ----- | 19,000 | 6 | 34.00 | 225 |
| 1-1/4 | 15,200 | 3,800 | 15,200 | 35,160 | 24,000 | 7 | 44.00 | 360 |

| Web & Roundsling Shackle | Web Eye Width (Inches) |
|--------------------------|------------------------|
| 6,500 | 1-2 |
| 9,000 | 3 |
| 12,500 | 4 |
| 17,000 | 5 |

| Swivel Hoist Rings | |
|--------------------|--------|
| Size | WLL |
| 3/8 | 1,000 |
| 1/2 | 2,500 |
| 5/8 | 4,000 |
| 3/4 | 5,000 |
| 7/8 | 8,000 |
| 1 | 10,000 |

Load Weights - Calculating

8

| Materials and Liquids - Pounds / cu. ft. | | | |
|--|-----|------------------|-----|
| Aluminum | 168 | Iron Casting | 460 |
| Asbestos | 153 | Lead | 710 |
| Asphalt | 80 | Lumber-Fir | 40 |
| Brass | 635 | Lumber-Oak | 62 |
| Brick | 120 | Lumber - RR Ties | 50 |
| Bronze | 500 | Oil, Motor | 58 |
| Coal | 56 | Paper | 60 |
| Concrete, Reinf. | 150 | Portland Cement | 94 |
| Crushed Rock | 95 | River Sand | 120 |
| Diesel | 53 | Rubber | 94 |
| Dry Earth, Loose | 74 | Steel | 480 |
| Gasolin | 45 | Water | 62 |
| Glass | 160 | Zinc | 437 |

| Pounds / sq. ft. | |
|------------------|------|
| Steel plate | |
| • 1/8 inch | 5 |
| • 1/4 inch | 10 |
| • 1/2 inch | 20 |
| • 1 inch | 40 |
| Aluminum plate | |
| • 1/8 inch | 1.75 |
| • 1/4 inch | 3.50 |
| Lumber | |
| • 3/4 inch Fir | 2.5 |
| • 3/4 inch Oak | 4.0 |

| Pounds / gallon | |
|-----------------|-----|
| Gasoline | 6.0 |
| Diesel | 7.0 |
| Water | 8.3 |

7.5 gallons of liquid to a cubic foot
27 cubic feet to a cubic yard

General Data

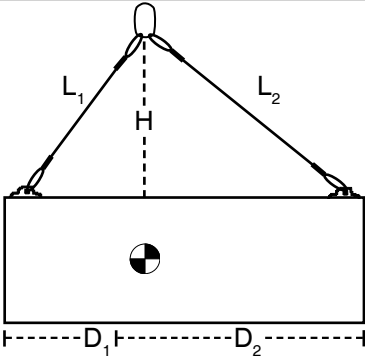
9

| | | |
|---|--|--|
| $A^2 + B^2 = C^2$ $C^2 - A^2 = B^2$ $C^2 - B^2 = A^2$ Area of a triangle = $AB/2$ | | <ul style="list-style-type: none"> • d = diameter • L = length • W = width • Circumference = πd • Volume = LWH • r = radius • H = height • π or Pi = 3.14 • Area of a circle = πr^2 • Area of a square = LW |
| Wire Rope D/d Ratio Strength Efficiencies 30:1 = .94 20:1 = .92 10:1 = .86 5:1 = .77 2:1 = .65 1:1 = .50 | 1 yard = 3 ft = 36 inches = .91 meter 1 meter = 1.09 yds = 3.28 ft = 39.37 in. 1 ton (short) = .891 long ton = .91 metric ton = 2,000 pounds = 907 kgs 1 ton (metric) = 1.1 short ton = .98 long ton = 2204 lbs = 1000 kgs 1 pound = .45 kg 1 kg = 1000 grams = 2.2 lbs 1 gallon (US liq) = 4 qts = 3.8 liters 1 liter = .264 gallon (US) = 1.06 qts 1 KIP = 1,000 lbs | |

This Reference Booklet is for testing purposes only.

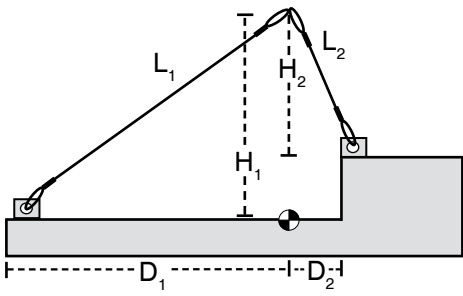
Level Pick Points

10

| Legend | | |
|---------------------------|---|--|
| W = Load Weight |  | |
| D1 = Distance of Side 1 | | |
| D2 = Distance of Side 2 | | |
| L1 = Sling Length, Side 1 | | |
| L2 = Sling Length, Side 2 | | |
| H = Vertical Height | | |
| TL1 = Tension, Length 1 | | |
| TL2 = Tension, Length 2 | | |
| | | $TL1 = \frac{(L1)(W)(D2)}{(H)(D1 + D2)}$ |
| | | $TL2 = \frac{L2(W)(D1)}{(H)(D1 + D2)}$ |

Off-level Pick Points




11

| Legend | |
|------------------------------|--|
| W = Load Weight |  |
| D1 = Distance of Side 1 | |
| D2 = Distance of Side 2 | |
| L1 = Sling Length, Side 1 | |
| L2 = Sling Length, Side 2 | |
| H1 = Vertical Height, Side 1 | |
| H2 = Vertical Height, Side 2 | |
| TL1 = Tension, Length 1 | |
| TL2 = Tension, Length 2 | |
| | |
| | $TL2 = \frac{W \times D1 \times L2}{(D2 \times H1) + (D1 \times H2)}$ |

3-Part Braided Wire Rope Sling Capacities (tons)




D/d of 4 for Component Parts of Body

12

| Equivalent to Standard Size Flemished Eye (inches) | Composed of 3 parts of EIP Rope (inches) |  |  |  | Finished Actual Diameter (inches) | Weight Per Ft. Approx. (pounds) |
|--|--|---|---|---|-----------------------------------|---------------------------------|
| 7/16 | 1/4 | 1.7 | 1.3 | 3.4 | 1/2 | .44 |
| 9/16 | 5/16 | 2.6 | 1.9 | 5.2 | 5/8 | .68 |
| 5/8 | 3/8 | 3.6 | 2.7 | 7.2 | 3/4 | .99 |
| 3/4 | 7/16 | 4.9 | 3.7 | 9.8 | 7/8 | 1.33 |
| 7/8 | 1/2 | 6.4 | 4.8 | 12.8 | 1 | 1.75 |
| 1 | 9/16 | 8.0 | 6.0 | 16.0 | 1-1/8 | 2.24 |
| 1-1/2 | 7/8 | 19.0 | 14.3 | 36.0 | 1-3/4 | 5.40 |
| 2 | 1-1/8 | 31.2 | 23.4 | 62.4 | 2-1/4 | 8.90 |
| 2-1/2 | 1-3/8 | 46.0 | 34.5 | 92.0 | 2-3/4 | 13.30 |
| 3 | 1-5/8 | 63.4 | 47.6 | 126.8 | 3-1/4 | 18.50 |
| 3-1/2 | 2 | 95.0 | 71.2 | 190.0 | 4 | 28.00 |
| 4 | 2-1/4 | 118.0 | 88.5 | 236.0 | 4-1/2 | 35.60 |
| 4-1/2 | 2-1/2 | 145.0 | 109.0 | 290.0 | 5 | 44.00 |

This Reference Booklet is for testing purposes only.






9-Part Braided Wire Rope Sling Capacities (tons)

| Finished Diameter (inches) | Component Parts (inches) | Hitches | | |
|----------------------------|--------------------------|---|---|---|
| | |  |  |  |
| 1/2 | 1/8 | 1.4 | 1.0 | 2.8 |
| 5/8 | 5/32 | 2.0 | 1.5 | 4.0 |
| 3/4 | 3/16 | 3.0 | 2.2 | 6.0 |
| 7/8 | 7/32 | 4.0 | 3.0 | 8.0 |
| 1 | 1/4 | 4.8 | 3.6 | 9.6 |
| 1-1/2 | 3/8 | 10.5 | 7.8 | 21.0 |
| 2 | 1/2 | 19.1 | 14.3 | 38.2 |
| 2-1/2 | 5/8 | 29.6 | 22.2 | 59.2 |
| 3 | 3/4 | 42.3 | 31.7 | 84.6 |
| 3-1/2 | 7/8 | 57.3 | 42.9 | 114.6 |
| 4 | 1 | 74.4 | 55.8 | 148.4 |
| 4-1/2 | 1-1/8 | 93.6 | 60.2 | 187.2 |

Ratings based on a minimum of a 1:1 D/d ratio in the eye of the sling. (D=Diameter of pin/D=sling bodies finished diameter.)

Alloy Chain Sling Capacities (lbs.)

Grade 80

| Size in inches | Single Leg | Two Leg Slings | | | Three & Four Leg Slings | | |
|----------------|---|---|---|---|--|---------|---------|
| |  |  |  |  |  | 60° | 45° |
| 9/32 | 3,500 | 2,800 | 6,100 | 4,900 | 3,500 | 9,100 | 7,400 |
| 3/8 | 7,100 | 5,680 | 12,300 | 10,000 | 7,100 | 18,400 | 15,100 |
| 1/2 | 12,000 | 9,600 | 20,800 | 17,000 | 12,000 | 31,200 | 25,500 |
| 5/8 | 18,100 | 14,480 | 31,300 | 25,600 | 18,100 | 47,000 | 38,400 |
| 3/4 | 28,300 | 22,640 | 49,000 | 40,000 | 28,300 | 73,500 | 60,000 |
| 7/8 | 34,200 | 27,360 | 59,000 | 48,400 | 34,200 | 88,900 | 72,500 |
| 1 | 47,700 | 38,160 | 82,600 | 67,400 | 47,700 | 123,900 | 101,200 |
| 1-1/4 | 72,300 | 57,840 | 125,200 | 102,200 | 72,300 | 187,800 | 153,400 |
| 1-1/2 | 80,000 | 64,000 | 138,600 | 113,100 | 80,000 | ----- | ----- |





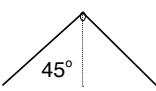
Grade 100

| | | | | | | |
|------|--------|--------|--------|--------|---------|--------|
| 9/32 | 4,300 | 7,500 | 6,100 | 4,300 | 11,200 | 9,100 |
| 3/8 | 8,800 | 15,200 | 12,400 | 8,800 | 22,800 | 18,600 |
| 1/2 | 15,000 | 26,000 | 21,200 | 15,000 | 39,000 | 31,800 |
| 5/8 | 22,600 | 39,100 | 32,000 | 22,600 | 58,700 | 47,900 |
| 3/4 | 35,300 | 61,100 | 49,900 | 35,300 | 91,700 | 74,900 |
| 7/8 | 42,700 | 74,000 | 60,400 | 42,700 | 110,900 | 90,600 |

This Reference Booklet is for testing purposes only.

High Capacity Round Sling (lbs.)*

15

| Dual-Path Model |  |  |  |  |  | Approx. Body Width (inches) |
|-----------------|---|---|---|--|---|-----------------------------|
| DP 1000 | 10,000 | 8,000 | 20,000 | 17,320 | 14,140 | 3 |
| DP 1500 | 15,000 | 12,000 | 30,000 | 25,980 | 21,210 | 3 |
| DP 2000 | 20,000 | 16,000 | 40,000 | 34,640 | 28,280 | 3 |
| DP 2500 | 25,000 | 20,000 | 50,000 | 43,300 | 35,350 | 3 |
| DP 3000 | 30,000 | 24,000 | 60,000 | 51,960 | 42,420 | 4 |
| DP 4000 | 40,000 | 32,000 | 80,000 | 69,280 | 56,560 | 4 |
| DP 5000 | 50,000 | 40,000 | 100,000 | 86,600 | 70,700 | 5 |
| DP 6000 | 60,000 | 48,000 | 120,000 | 103,920 | 84,840 | 5 |
| DP 7000 | 70,000 | 56,000 | 140,000 | 121,240 | 98,980 | 5 |
| DP 8500 | 85,000 | 68,000 | 170,000 | 147,220 | 120,190 | 6 |
| DP 10000 | 100,000 | 80,000 | 200,000 | 173,200 | 141,400 | 6 |
| DP 12500 | 125,000 | 100,000 | 250,000 | 216,500 | 176,750 | 8 |
| DP 15000 | 150,000 | 120,000 | 300,000 | 259,800 | 212,100 | 8 |
| DP 17500 | 175,000 | 140,000 | 350,000 | 303,100 | 247,450 | 10 |
| DP 20000 | 200,000 | 160,000 | 400,000 | 346,400 | 282,800 | 10 |
| DP 25000 | 250,000 | 200,000 | 500,000 | 433,000 | 353,500 | 10 |
| DP 27500 | 275,000 | 220,000 | 550,000 | 476,300 | 388,850 | 12 |
| DP 30000 | 300,000 | 240,000 | 600,000 | 519,600 | 424,200 | 12 |
| DP 40000 | 400,000 | 320,000 | 800,000 | 692,800 | 565,600 | 14 |
| DP 50000 | 500,000 | 400,000 | 1,000,000 | 866,000 | 707,000 | 16 |

*Capacities shown include both paths and are for one complete sling, sling ratings based on fittings of equal or greater capacity.

Web Sling Shackle

16

| Round Sling Size (No.) | Web Slings* | | Working Load Limit (Tons) [†] |
|------------------------|---------------------|-----------------|--|
| | Webbing Width (in.) | Eye Width (in.) | |
| 1 | 2 | 2 | 3-1/4 |
| 2 | 2 | 2 | 3-1/4 |
| 3 | 3 | 1.5 | 4-1/2 |
| 4 | 4 | 2 | 6-1/4 |
| 5 | 6 | 3 | 8-1/2 |
| 6 | 6 | 3 | 8-1/2 |

* NOTE: Designed for use with Type III, (Eye & Eye), Class 7, 2 Ply web slings. For 3" and larger webbing width, tapered eye is required.

[†] Maximum Proof Load is 2-1/2 times the Working Load Limit. Minimum Ultimate strength is 5 times the Working Load Limit.

This Reference Booklet is for testing purposes only.

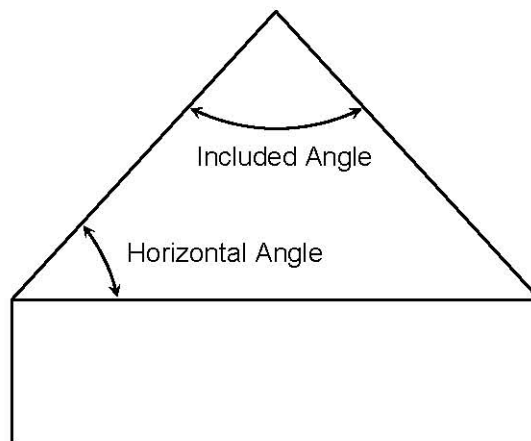
Alloy Master Links

17

| Size "A" (in) | Working Load Limit (lbs.)* |
|---------------------|----------------------------------|
| 1/2 | 7000 |
| 5/8 | 9000 |
| 3/4 | 12300 |
| 7/8 | 15000 |
| 1 | 24360 |
| 1-1/2 | 54300 |
| 2 | 102600 |
| 2-1/2 | 160000 |
| 3 | 228000 |
| 3-1/2 | 279000 |
| 4 | 373000 |
| 4-1/2 | 360000 |
| 5 | 395000 |

Included and Horizontal Angles

18



This Reference Booklet is for testing purposes only.



**NATIONAL COMMISSION FOR THE
CERTIFICATION OF CRANE OPERATORS**

2750 Prosperity Avenue, Suite 505
Fairfax, VA 22031 - 4312

Phone: 703-560-2391
Fax: 703-560-2392
info@nccco.org