CDOT Construction Manual

APPENDIX D
MISCELLANEOUS DATA

March 2014

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APPENDIX D
MISCELLANEOUS DATA

Appendix D presents common tables, figures, and miscellaneous data that Project Engineers and Project Inspectors will use on a day-to-day basis. These include such items as legal dimensions and weights for trucks, procedures for measuring and documenting vertical and lateral clearances at structures, grade stamps used by accredited lumber inspection agencies, and miscellaneous mathematical formulas.

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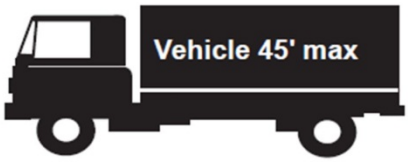
Colorado Department of Transportation
For Your Information (FYIs)

LEGAL VEHICLE DIMENSIONS (CDOT FYI 1)

The figures below reflect legal size limitations, any dimensions exceeding these limitations will require an oversize permit **C.R.S. 42-4-510(11).** The metric equivalents are not part of the statutory references, but are displayed only for informational purposes.



Single unit maximum length is **45' (13.72 meters)** as measured from extreme front bumper to extreme rear bumper. **C.R.S. 42-4-504(2)**

No overall length limit for a combination with a single trailer length of **57' 4" (14.47 meters)** or less in length. **C.R.S. 42-4-504(4)**

No overall length limit for a combination of units with trailers **28'6" (8.68 meters)** or less in length. The common name for this combination is "Western Double". **C.R.S. 42-4-504(4)**

Saddlemounts are allowed 97' **(29.57 meters)** in length for no more than **4** total units. A fullmount also may be transported as part of this combination. A fullmount is a smaller vehicle that is mounted completely on the frame of either the first or last vehicle i n a saddlemount combination. **C.R.S. 42-4-504(4.5)**

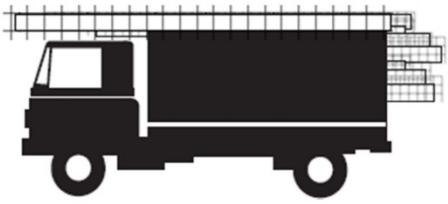
Colorado Department of Transportation
For Your Information (FYIs)

15' (4.57 meters) Drawbar

When one vehicle is towing another the drawbar or other connection shall be of sufficient strength to pull all weight towed, and the drawbar or other connection shall not exceed **15** feet **(4.57 meters)** from one vehicle to the other **C.R.S. 42-4-506(1)**

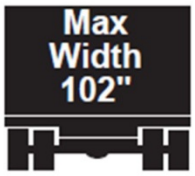
Load may not project more than **4** feet **(1.22 meters)** from the front most part of the grill. **C.R.S. 42-4-504(5)**

DAYLIGHT TRAVEL - Red flags are required at the end of the load projections greater than **4** feet **(1.22 meters)**. **C.R.S. 42-4-209**



Load may not project more than **10** feet **(3.05 meters)** to the rear of the vehicle bumper. Overhangs for automobile and boat transporters are restricted to **6** feet **(1.83 meters)**. **C.R.S. 42-4-504(6)**

NIGHT TRAVEL - A red light or lantern is required at the end of the load projections greater than **4** feet **(1.22 meters)**. **C.R.S. 42-4-209**



The total outside width of any vehicle or load shall not exceed **102" (2.59 meters)**, excluding mirrors or safety devices. **C.R.S. 42-4-502 (1), (5)**

No vehicle unladen or with load shall exceed a height of **13' (3.96 meters)**; except that vehicles with a height of **14' 6" (4.42 meters)** shall be operated only on highways designated by the State Department of Transportation. **C.R.S. 42-4-504(1)**

PERMIT FEES FOR VEHICLES THAT EXCEED LEGAL VEHICLE LIMITATIONS C.R.S. 42-4-510 (11)

Single Trip Permit	(Oversize)	$15.00*
	(Special)	$125.00* required when a load exceeds maximum extra-legal dimensions.
Annual Permit	(Oversize)	$250.00 per permitted power unit.
Annual Fleet Permit	(Overlength)	This fleet permit only applies to public utility vehicles and loads. $1,500.00 plus $15.00 per fleet vehicle.

For detailed information and requirements concerning oversize/overweight permits, please refer to the Department of Transportation's Rules and Regulations titled "Pertaining to Transport Permits for the Movement of Extra-Legal Vehicles or Loads" (2 CCR 601-4). **For more information contact CDOT at (303) 757-9539 or 1-800-350-3765.**

*Effective July 1, 2009 – Single trip and special transport permits will be assessed a surcharge equal to the permit fee.

Colorado Department of Transportation
For Your Information (FYIs)

LEGAL VEHICLE WEIGHT LIMITS (CDOT FYI 2)

The figures below reflect legal weight limits **C.R.S. 42-4-508**, any weights exceeding these limitations will require an overweight permit **C.R.S. 42-4-510(11)**. The metric equivalents are not part of the statutory references, but are displayed only for informational purposes.

- A single axle shall not exceed 20,000 pounds (9,072 kg). ❶
- Tandem axles shall not exceed 36,000 pounds (16,330 kg), 40,000 pounds (18,144 kg) non-interstate.

TWO AXLE/SINGLE UNIT

Maximum gross weight allowed on any Non-Interstate Colorado highway is limited to the Colorado Bridge Formula. * ❷

Gross Weight = (Length + 40) x 1,000

C.R.S. 42-4-508 (1)(b)

THREE OR MORE AXLES/SINGLE UNIT

Maximum gross weight allowed on any Interstate highway is limited to the Federal Bridge Formula. * ❷

Gross Weight = 500 (LN/N-1 + 12N + 36)

* Total weight must be distributed so that no single or tandem axle exceeds the maximum gross weight limits allowed on the road where they are weighed. C.R.S. 42-4-508(1)(c)

NON-INTERSTATE HAULERS

Maximum gross weight allowed on any Colorado non-interstate highway is 85,000 pounds (38,556 kg). ❷

In addition vehicles must comply with the axle weight limitations and the Colorado Bridge Formula. C.R.S. 42-4-508(1)(b)

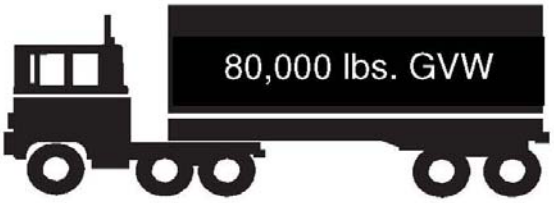
Gross Weight = (Length + 40) x 1,000

❶ A single axle shall not exceed 21,000 pounds (9,530 kg) for digger-derrick or bucket boom trucks operated by an electric utility on a non-interstate highway. C.R.S. 42-5-507(2)(b.5)

❷ Gross weight limits are increased by 1,000 pounds (450 kg) for vehicles or combination of vehicles that contain an alternative fuel system and that operate on alternative fuel and conventional fuel on the non-interstate highways. C.R.S. 42-5-508(1.5)

Colorado Department of Transportation
For Your Information (FYIs)

INTERSTATE HAULERS



Maximum gross weight allowed on any Colorado Interstate highway is **80,000 pounds (36,288 kg).** In addition vehicles traveling on interstate highways must comply with the Federal Bridge Formula.
C.R.S. 42-4-508 (1)(c)

Gross weight = 500 (LN/N-1 + 12N + 36)

FEDERAL BRIDGE FORMULA

Gross weight = 500 (LN/N-1 + 12N + 36)

L = Distance in feet between the extremes of any group of two or more consecutive axles.

N = Number of axles being considered. In computations of this formula no gross vehicle weight shall exceed 80,000 pounds except as may be authorized under Section 42-4-510(II).

PERMIT FEES FOR VEHICLES THAT EXCEED LEGAL WEIGHT LIMITATIONS C.R.S. 42-4-510(11)

Single Trip Permit	Overweight	$15.00 plus $5.00 per axle*
	Non-Interstate Overweight Divisible Load – 2/3 Axle Trailer	$15.00 plus $10 per axle*
	Non-Interstate Overweight Divisible Load – Quad Axle	$30.00 plus $10 per axle
Special	$125.00* This special permit is for structural, oversized, or overweight moves requiring extraordinary action or moves involving weight in excess of two hundred thousand pounds.	
Annual Permit Overweight	$400.00 per permitted power unit.	

Annual Non-Interstate Overweight Divisible Load Permit (NIOWD) – for either the 2/3 Axle Trailer or Quad Axle Permit – $500.00

6-Month Non-Interstate Overweight Divisible Load Permit – for the 2/3 Axle Trailer Permit – $250.00

Annual Fleet Permit

LVC Overweight	This fleet permit only applies to Longer Vehicle Combinations as defined in C.R.S. 42-4-505. $1,500.00 plus $25.00 per vehicle to be permitted.
NIOWD Quad	This fleet permit only applies to Non-Interstate Divisible Load permits where the vehicle has a quad-axle configuration. $2,000 plus $35.00 per vehicle to be permitted.

Payment for permits will be accepted as follows:

1. Cash
2. Check
3. Escrow Accounts
4. Visa or MasterCard
5. Cash

For detailed information and requirements concerning overweight/oversize permits, please refer to the Department of Transportation's Rules and Regulations titled "Pertaining to Transport Permits for the Movement of Extra-Legal Vehicles of Loads" (2 CCR 601-4). **For more information contact CDOT at (303) 757-9539 or 1-800-350-3765.**

*Effective July 1, 2009- Single trip and special transport permits will be assessed a surcharge equal to the permit fee.

Colorado Department of Transportation
For Your Information (FYIs)

LONGER VEHICLE COMBINATIONS (CDOT FYI 3)

A Longer Vehicle Combination (LVC) **(C.R.S. 42-4-505)** shall not have more than three cargo units, fewer than six axles nor more than nine axles. The heaviest gross weight shall be hauled in the first semitrailer. LVCs must obtain a special permit and may only travel on designated routes. LVCs, except the "Truck with Trailer" combination, have no overall length limitation. Vehicle weight (GVW) is 80,000 pounds (36,288 kg) unless an overweight permit is purchased. **C.R.S. 42-4-510(11)** - (The metric equivalents are not part of the statutory references, but are displayed only for informational purposes.)

An unladen truck tractor, one semitrailer which shall not exceed 48' (14.63 meters) and one trailer which shall not exceed 28' 6" (8.68 meters). The shorter trailer shall be operated as the rear trailer. The common name for this combination is "Rocky Mountain Double." **C.R.S. 42-4-505 (2)(c)**

An unladen truck tractor, one semitrailer and trailer which shall be of approximately equal lengths not to exceed 48' (14.63 meters). This combination may operate with up to eleven axles provided that the trailers are empty. The common name for this combination is "Turnpike Double." **C.R.S. 42-4-505 (2)(b)**

An unladen truck tractor, one semitrailer and two trailers which shall be of approximately equal lengths not to exceed 28' 6" (8.68 meters). The common name for this combination is "Triple." **C.R.S. 42-4-505 (2)(a)**

One single unit truck and trailer which shall not exceed 85' (25.91 meters). The truck shall not be more than 35' (10.67 meters) and the trailer not more than 40' (12.19 meters). The common name for this combination is "Truck With Trailer." **C.R.S. 42-4-505 (2)(d)**

Colorado Department of Transportation
For Your Information (FYIs)

DESIGNATED ROUTES

a) On I-25 from the Colorado-New Mexico state line to the Colorado-Wyoming state line.
b) On I-70 from the junction of US 40 and SH 26, in Denver, to the Colorado-Kansas state line.
c) On I-76 from the junction of I-70, in Denver, to the Colorado-Nebraska state line.
d) On I-270 from the junction of I-70 to the junction of I-76.
e) On I-225 from the junction of I-25 to the junction of I-70.
f) On I-70 from the Colorado-Utah state line to the junction of SH 13.
g) On SH 133, in Delta County, from Milepoint 8.9 to Milepoint 9.7 (Non-Interstate Highway).

HOURS OF OPERATION

A LVC shall not operate on the following designated highway segments during the hours of 7:00 a.m. to 9:00 a.m. and from 4:00 p.m. to 6:00 p.m., Monday through Friday, for Colorado Springs, Denver, and Pueblo. LVCs operating above the legal maximum weight are subject to different hours of operation restrictions. Refer to rules pertaining to Extra-Legal Vehicles or Loads.

Colorado Springs	I-25 from Academy Blvd South to Academy Blvd North
Denver	I-25 from I-225 to SH 128 (120th Ave) I-70 from US 40/SH 26 to I-225 I-76 from I-70 to SH 85 I-225 from I-25 to I-70 I-270 from I-76 to I-70
Pueblo	I-25 from Lake Ave (Exit #94) to SH 47/SH 50 (Exit #101)

INGRESS AND EGRESS

Longer Vehicle Combinations can be permitted to go to the following facilities: **1)** Manufacturing or distribution centers, warehouses, or truck terminals, that are located in an area where industrial uses are permitted; and, **2)**. Construction sites. This off-highway-segment travel is limited to a maximum of 10 miles which shall be measured by the most direct travel rather than by the radius from the facility to the designated route. The ingress and egress route(s) between the designated state highway segment and the facility must be approved in advance by the public entity (CDOT, municipality, or county) having jurisdiction for the roadway(s) that make up the route(s).

MAXIMUM WEIGHTS

The legal maximum gross vehicle weight of a longer vehicle combination is 80,000 pounds (36,288 kg), the vehicle shall not exceed 20,000 pounds (9,072 kg) on any single axle or 36,000 pounds (16,330 kg) on any tandem axle and the vehicle must comply with the Federal Bridge Formula. If an overweight permit is purchased, the vehicle must comply with the aforementioned axle weight limitations and the maximum gross vehicle weight shall not exceed the **minimum** of any of the following conditions:

1. 110,000 pounds (49,896 kg)
2. 800 (L + 40)
3. 500 (LN/N-1 + 12N + 36)

For more details see the Department of Transportation's Rules and Regulations titled "Pertaining to Transport Permits for the Movement of Extra-Legal Vehicles or Loads" (2 CCR 601-4). For more information contact CDOT at (303) 757-9539 or 1-800-350-3765.

PERMIT FEES C.R.S.42-4-505(1)

Annual Permit; $250.00 for each applicant.

For more detailed information and requirements concerning a Longer Vehicle Combination permit, please refer to the Department of Transportation's Rules and Regulations titled "Operation of Longer Vehicle Combinations on Designated State Highway Segments" (2 CCR 601-9). **For more information contact CDOT at (303) 757-9539 or 1-800-350-3765.**

HAZARDOUS MATERIALS

For more detailed information concerning the transportation of hazardous materials on Longer Vehicle Combinations, refer to the Department of Public Safety's Rules and Regulations titled "Hazardous Materials Transportation Permits" (8 CCR 1507-25). **For more information contact CSP at (303) 273-1900.**

CDOT Non-Interstate Overweight Divisible Permits

Fact Sheet

Non-Interstate Quad Axle Overweight Divisible Permits

Effective October, 2008

- Overweight permits only (no oversize/over dimension)
- Non-interstate highways only
- Vehicle must be configured with a quad axle grouping
- Cannot exceed 110,000 lbs. gross vehicle weight
- Must comply with maximums on CDOT Bridge Weight Limit Map
- Single trip permit available. Fee: $30 + $10 per axle
- Annual permit available. Fee: $500
- Annual Fleet Permit available. Fee: $2,000 + $35 per permitted vehicle
- Substantial fines may be assessed for violations

Non-Interstate Tandem/Triple Axle Overweight Divisible Permits

Effective January 1, 2010

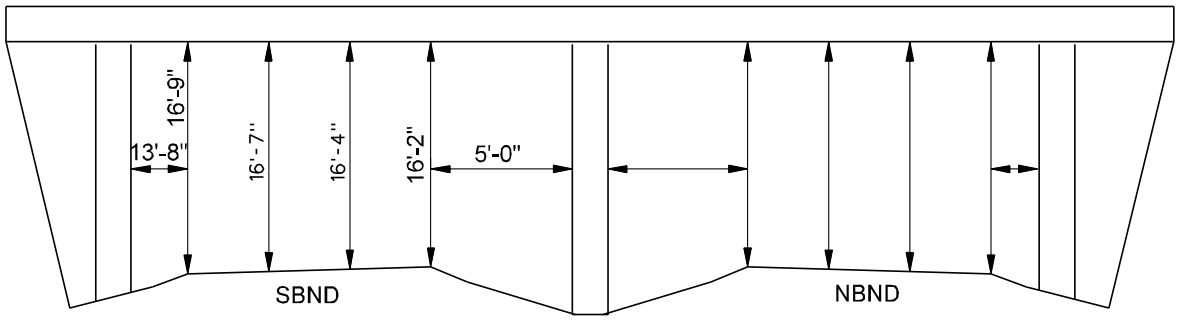
- Overweight permits only (no oversize/over dimension)
- Non-interstate highways only
- Applies to tractor/trailer combination vehicles only
- Must have either tandem or triple axle grouping on trailer
- Cannot exceed 97,000 lbs. gross vehicle weight
- Must comply with maximums on CDOT Bridge Weight Limit Map
- Single trip permit available. Fee: $15 +$10 per axle, plus a surcharge equal to the total amount of the permit
- Six-month permit available. Fee: $250
- Annual permit available: Fee: $500
- Substantial fines may be assessed for violations

To view Legislation click on the respective link:

- Quad Axle Non-Interstate Overweight Divisible Permits – HB 08-1257
- Tandem/Triple Axle Overweight Divisible Permits – HB 09-1318

Fact sheet compiled September 16, 2009

PROCEDURE FOR MEASURING AND DOCUMENTING VERTICAL AND LATERAL CLEARANCES FOR BRIDGES AND SIGNS
(Applicable to New Construction, Reconstruction, Overlay, and Rehabilitation Projects)



LOOKING N

I-25

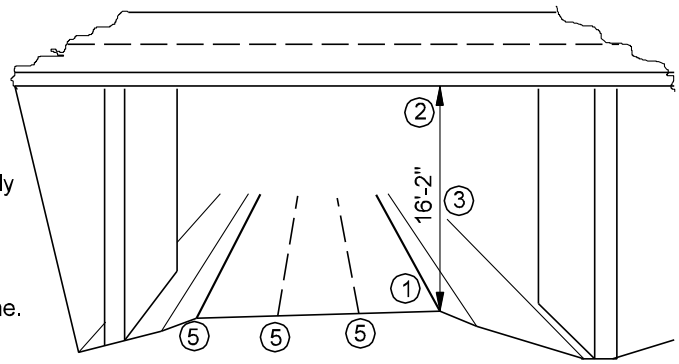
EXAMPLE SHOWING 16th ST BRIDGE OVER I-25

Recording Vertical and Lateral Clearances

1. Make an accurate sketch of bridge or sign structure.
2. Take measurements of vertical clearances as shown below. Be sure to measure the clearances under all the girders to determine the minimum along each lane line. Also meaure and record lateral clearances.
3. On sign structures, the minimum may not be the sign support. It may be a cat walk or an appurtenance hanging lower.
4. Record the measurements on a sketch of the bridge or sign as shown above.
5. Note which direction you are looking on the sketch. On a divided highway, record measurements for both structures while looking in one direction only. Do not look in the direction of traffic for each of the bridges.
6. Send the information to Bridge Records, c/o Staff Bridge Branch. If less than 16'-6", notify Staff Maintenance - Oversize/Overweight Permits (See Section 630.2.4 and Construction Bulletin, January 20, 2001).

Where to Measure Vertical Clearances

1. Locate the edge of roadway, excluding shoulder. Typically, a solid white line represents the edge of roadway.
2. Locate the lowest point of the structure directly above that line.
3. Measure the clearance.
4. Record the measurement.
5. Repeat steps 2, 3, and 4 for each roadway line.



American Lumber Standard Committee, Incorporated

R.K. Caron, Chairman
T.F. Brodie, Vice Chairman
H.B. Sager, Treasurer
T.D. Searles, President

P.O. Box 210
Germantown, Maryland 20875-0210
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E-Mail: alsc@alsc.org

February 2013
(this list supersedes all previous lists)

The following rules have been certified as conforming to the American Softwood Lumber Standard, PS20, by the Board of Review of the American Lumber Standard Committee:

1. **Standard Grading Rules for Northeastern Lumber**; published by the Northeastern Lumber Manufacturers Association (NeLMA), 272 Tuttle Road, P.O. Box 87A, Cumberland Center, ME 04021; phone 207.829.6901; fax 207.829.4293

2. **Standard Grading Rules**; published by the Northern Softwood Lumber Bureau (NSLB), 272 Tuttle Road, P.O. Box 87A, Cumberland Center, ME 04021; phone 207.829.6901; fax 207.829.4293

3. **Standard Specifications for Grades of California Redwood Lumber**; published by the Redwood Inspection Service (RIS), 818 Grayson Road, Suite 201, Pleasant Hill, CA 94523-2693; phone 925.935.1499; fax 925.935.1496

4. **Standard Grading Rules for Southern Pine Lumber**; published by the Southern Pine Inspection Bureau (SPIB), 4709 Scenic Highway, Pensacola, FL 32504; phone 850.434.2611; fax 850.433.5594

5. **Standard Grading Rules for West Coast Lumber**; published by the West Coast Lumber Inspection Bureau (WCLIB), Box 23145, Portland, OR 97281-3145; phone 503.639.0651; fax 503.684.8928

6. **Western Lumber Grading Rules**; published by the Western Wood Products Association (WWPA), 522 SW Fifth Avenue, Portland, OR 97204-2122; phone 503.224.3930; fax 503.224.3934

7. **Standard Grading Rules for Canadian Lumber**; published by the National Lumber Grades Authority (NLGA), Suite 105, 13401-108th Avenue, Surrey, BC V3T 5T3; phone 604.584.2393; fax 604.584.2890

Agencies Accredited by the Board of Review of the American Lumber Standard Committee, Incorporated and Typical Grade Stamps.

TYPICAL GRADE STAMP | AGENCY NAMES & ADDRESSES

MILL 000
CONTINENTAL INSPECTION AGENCY
STAND & BTR
DOUG FIR S-GRN

Continental Inspection Agency, LLC (CI)
P.O. Box 785
Lodi, CA 95241

209.367.3840
916.718.5217
fax: 209.367.3840
e-mail: drdodgerman@sbcglobal.net

1. Approval as an inspection agency including mill supervisory services under:
   a. WWPA rules
   b. WCLIB rules
   c. RIS rules
   d. NGR portion of the NLGA rules
2. Approved to provide heat treatment audit services under all rules.

S-DRY 001
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EASTERN WHITE PINE

S-DRY 001
STAND
EASTERN WHITE PINE NELMA®

Northeastern Lumber Manufacturers Association (NeLMA)
272 Tuttle Road, P.O. Box 87A
Cumberland Center, ME 04021
207.829.6901
fax: 207.829.4293
e-mail: info@nelma.org

1. NeLMA is a rules writing agency.
2. Approval of rules they publish and as an inspection agency including mill supervisory services under:
   a. NeLMA rules
   b. NSLB rules
   c. NGR, Posts and Timbers, and Beams and Stringers portions of WCLIB rules
   d. NGR, Selects and Common Boards, 4/4 Shop, Heavy Shop, Posts and Timbers, and Beams and Stringers under the WWPA rules
   e. NGR portion of the SPIB rules
   f. NGR portion of the NLGA rules
3. Approved to supervise glued and machine graded lumber.
4. Approved to provide heat treatment audit services under all rules.

110 STUD
S-DRY
BALSAM FIR

Northern Softwood Lumber Bureau (NSLB)
272 Tuttle Road, P.O. Box 87A
Cumberland Center, ME 04021
207.829.6901
fax: 207.829.4293
e-mail: info@nelma.org

1. NSLB is a rules writing agency
2. Approval of rules they publish and as an inspection agency including mill supervisory service under:
   a. NSLB rules
   b. NGR portion of WCLIB rules
   c. NGR portion of the WWPA rules
   d. NGR portion of NLGA rules
3. Approved to supervise glued and machine graded lumber.
4. Approved to provide heat treatment audit services under all rules.

W-10
CONST
S-GRN
® HEM-FIR WCLB RULES

Pacific Lumber Inspection Bureau (PLIB)
1010 South 336th Street
Suite 300
Federal Way, WA 98003
253.835.3344
fax: 253.835.3371
e-mail: info@plib.org

1. Approval as an inspection agency including mill supervisory service under:
   a. WCLIB rules
   b. WWPA rules
   c. RIS rules
   d. NLGA rules
2. Approved to supervise glued and machine graded lumber.
3. Approved to provide heat treatment audit services under all rules.

MILL 001
DECK COM
S-DRY REDWOOD

Redwood Inspection Service (RIS)
818 Grayson Road, Suite 201
Pleasant Hill, CA 94523-2693
925.935.1499
fax: 925.935.1496
e-mail: info@calredwood.org

1. RIS is a rules writing agency.
2. Approval of rules they publish and as an inspection agency including mill supervisory service under:
   a. RIS rules
   b. WCLIB rules
   c. WWPA rules
3. Approval to supervise machine graded lumber.
4. Approved to provide heat treatment audit services under all rules.

RRA® No 2 KD
048 SYP HT

RRA® No 1
028 SYP KD19

Renewable Resource Associates, Inc. (RRA)
860 Johnson Ferry Road
Suite 140-194
Atlanta, GA 30342

678.528.3734 or 770.330.9416
fax: 678.528.8082
e-mail: lon@rrainc.net

1. Approval as an inspection agency including mill supervisory service under:
    a. SPIB rules
    b. NGR, Posts and Timbers, and Beams and Stringers portions of the NLGA rules
    c. NGR, Selects and Finish, Boards, Posts and Timbers, and Beams and Stringers portions of the WWPA rules
    d. NGR, Posts and Timbers, and Beams and Stringers portions of the WCLIB rules
    e. NGR, Selects and Finish, Boards, Posts and Timbers, and Beams and Stringers portions of the NeLMA rules
    f. NGR, Selects and Finish, Boards, Mouldings, Posts and Timbers, and Beams and Stringers portions of the NSLB rules
2. Approved to supervise glued and machine graded lumber.
3. Approved to provide heat treatment audit services under all rules.

SPIB® No.2
KD19 HT 7

Southern Pine Inspection Bureau (SPIB)
P.O. Box 10915
Pensacola, FL 32524-0915

850.434.2611
fax: 850.433.5594
e-mail: spib@spib.org

1. SPIB is a rules writing agency
2. Approval of rules they publish and as an inspection agency including mill supervisory service under:
    a. SPIB rules
    b. Southern Pine graded under WWPA Moulding Stock and Shop Lumber rules
    c. NGR, Posts and Timbers, and Beams and Stringers portions of NeLMA rules
    d. NGR, Posts and Timbers, and Beams and Stringers portions of NSLB rules
    e. NGR, Posts and Timbers, and Beams and Stringers portions of WCLIB rules
    f. NGR, Western Patio Decking, Posts and Timbers, and Beams and Stringers portions of WWPA rules
    g. NGR, Posts and Timbers, and Beams and Stringers portions of NLGA rules
3. Approved to supervise glued and machine graded lumber.
4. Approved to provide heat treatment audit services under all rules.

SIWP® 000
NO.2 S-DRY SYP

Stafford Inspection and Consulting, LLC (SIWP)
14418 Roxane Drive
Orlando, FL 32832

407.380.7914
fax: 407.380.8914
e-mail: info@staffordinspection.com

1. Approval as an inspection agency including mill supervisory service under:
    a. NGR, Timbers, Stress Rated Boards, Radius Edge Decking, Finish, and Boards portions of SPIB rules
    b. NGR, Selects and Common Boards, Shop and Mouldings, Western Patio Decking, Beams and Stringers, and Posts and Timbers portions of the WWPA rules
    c. NGR and Alternate Decking portions of the WCLIB rules
    d. NGR, Paragraph 112-Selects, Paragraph 113-Commons, Posts and Timbers, and Beams and Stringers portions of the NLGA rules
    e. NGR, Section 7-Selects and Commons, Posts and Timbers, and Beams and Stringers portions of the NSLB rules
    f. NGR, Section 7-Selects and Commons, Posts and Timbers, and Beams and Stringers portions of the NeLMA rules
2. Approved to provide heat treatment audit services under all rules.

Timber Products Inspection (TP)
P.O. Box 919 770.922.8000
Conyers, GA 30012 fax: 770.922.1290
e-mail: dconner@tpinspection.com

1. Approval as an inspection agency including mill supervisory service under:
   a. SPIB rules
   b. RIS rules
   c. WCLIB rules
   d. WWPA rules
   e. NGR, Posts and Timbers, and Beams and Stringers, and Section 6-Eastern White Pine Board Grades portions of the NeLMA rules
   f. NGR, paragraph 112-Selects, and paragraph 113-Commons portions of the NLGA rules
   g. NGR portion of the NSLB rules
2. Approved to supervise glued and machine graded lumber.
3. Approved to provide heat treatment audit services under all rules.

West Coast Lumber Inspection Bureau (WCLIB)
P.O. Box 23145 503.639.0651
Portland, OR 97281-3145 fax: 503.684.8928
e-mail: info@wclib.org

1. WCLIB is a rules writing agency.
2. Approval of rules they publish and as an inspection agency including mill supervisory service under:
   a. WCLIB rules
   b. RIS rules
   c. WWPA rules
   d. NLGA rules
   e. NGR, Scaffold Plank, Radius Edge Decking, Finish and Boards portions of the SPIB rules
3. Approved to supervise glued and machine graded lumber.
4. Approved to provide heat treatment audit services under all rules.

Western Wood Products Association (WWPA)
522 SW Fifth Avenue, Suite 500 503.224.3930
Portland, OR 97204-2122 fax: 503.224.3934
e-mail: info@wwpa.org

1. WWPA is a rules writing agency.
2. Approval of rules they publish and as an inspection agency including mill service under:
   a. WWPA rules
   b. WCLIB rules
   c. NLGA rules
   d. RIS rules
   e. NGR and Scaffold Plank portions of the SPIB rules
   f. Section 6.2-Eastern White Pine Common Board Grades of the NeLMA rules
3. Approved to supervise glued and machine graded lumber.
4. Approved to provide heat treatment audit services under all rules.

National Lumber Grades Authority (NLGA)
Suite 105, 13401 – 108th Ave.
Surrey, BC V3T 5T3
604.584.2393
fax: 604.584.2890
e-mail: info@nlga.org

The NLGA is the rules writing agency for Canada. The following Canadian agencies have been accredited by the Board of Review of the American Lumber Standard Committee as inspection agencies including mill supervisory service as indicated below.

A.F.P.A.® 00
S-P-F NLGA
KD-HT 1

Alberta Forest Products Association (AFPA)
Suite 900, 10707 100 Avenue
Edmonton, AB T5J 3M1
780.452.2841
fax: 780.455.0505
e-mail: info@albertaforestproducts.ca

1. Approved as an inspection agency including mill supervisory service under:
   a. NLGA rules
2. Approved to supervise glued and machine graded lumber.
3. Approved to provide heat treatment audit services under all rules.

COFI No 1 S-DRY NLGA 100 HEM-FIR(N)

CMSA No 1 KD-HT NLGA 100 S-P-F

CMSA 100 HT

Canadian Mill Services Association (CMSA)
#200, 601-6th Street
New Westminster, BC V3L 3C1
604.523.1288
fax: 604.523.1289
e-mail: sing@canserve.org

1. Approved as an inspection agency including mill supervisory service under:
   a. NLGA rules
   b. NGR portion of WWPA rules for Douglas fir, larch, and SPF(S)
2. Approved to supervise glued and machine graded lumber.
3. Approved to provide heat treatment audit services under all rules.

CSI No 1 S-DRY 000 HEM-FIR(N)

0 No. 2 S-GRN D-FIR(N) NLGA

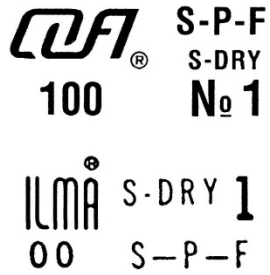
Canadian Softwood Inspection Agency, Inc. (CSI)
MacDonald Inspection Services (MI)
Brookswood RPO
P.O. Box 61599
Langley, BC V3A 8C8
604.535.6192
888.331.8200
fax: 604.535.6412
e-mail: info@canadiansoftwood.com

1. Approved as an inspection agency including mill supervisory service under:
   a. NLGA rules
   b. NGR, Posts and Timbers, and Beams and Stringers portions of WWPA rules
   c. NGR, Posts and Timbers, and Beams and Stringers portions of WCLIB rules
2. Approved to supervise glued and machine graded lumber.
3. Approved to provide heat treatment audit services under all rules.

CFPA® 00
S-P-F S-DRY
CONST

Central Forest Products Association (CFPA)
10709 Jasper Ave., # 500
Edmonton, AB T5J 3N3
780.452.2841
780.455.0505
e-mail: info@albertaforestproducts.ca

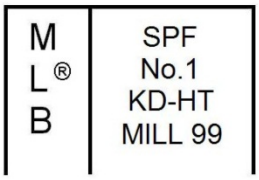
1. Approved as an inspection agency including mill supervisory service under:
   a. NLGA rules
   b. NGR portion of NeLMA rules
2. Approved to supervise glued and machine graded lumber.
3. Approved to provide heat treatment audit services under all rules.



Council of Forest Industries (COFI)

Suite 1501, 700 West Pender St.	604.684.0211
Pender Place I Business Building	fax: 604.687.4930
Vancouver, BC V6C 1G8	e-mail: info@cofi.org
Southern Region	250.860.9663
360-1855 Kirschner Rd.	fax: 250.860.0009
Kelowna, BC V1Y 4N7	e-mail: crooks@cofi.org
	desrosier@cofi.org
Northern Region	250.564.5136
400-1488 Fourth Ave.	fax: 250.860.0009
Prince George, BC V2L 4Y2	e-mail: routledge@nfpa.bc.ca

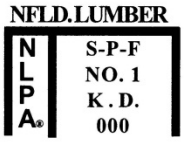
1. Approved as an inspection agency including mill supervisory service under:
   a. NLGA rules
   b. NGR portion of WWPA rules
2. Approved to supervise glued and machine graded lumber.
3. Approved to provide heat treatment audit services under all rules.



Maritime Lumber Bureau (MLB)

P.O. Box 459	902.667.3889
Amherst, NS B4H 4A1	fax: 902.667.0401
	e-mail: mlb@ns.sympatico.ca

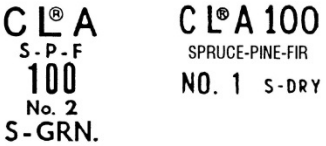
1. Approved as an inspection agency including mill supervisory service under:
   a. NLGA rules
   b. NGR and Section 6-Eastern White Pine Board Grades portions of the NeLMA rules
2. Approved to supervise glued lumber.
3. Approved to provide heat treatment audit services under all rules.



Newfoundland and Labrador Lumber Producers Association (NLPA)

P.O. Box 8	709.533.2206
Glovertown, NF A0G 2L0	fax: 709.533.2611
	e-mail: nllpa@nf.sympatico.ca

1. Approved as an inspection agency including mill supervisory service under:
   a. NLGA rules
2. Approved to provide heat treatment audit services under all rules.



Ontario Forest Industries Association (OFIA) – Home of CLA Grading and Inspection

10 King Street East, Suite 300	416.368.6188
Toronto, ON M5C 1C3	fax: 416.368.5445
	e-mail: info@ofia.com

1. Approved as an inspection agency including mill supervisory service under:
   a. NLGA rules
   b. NGR and Section6-Eastern White Pine Board Grades portions of NeLMA rules
2. Approved to supervise glued and machine graded lumber.
3. Approved to provide heat treatment audit services under all rules.

O.L.M.A.® 01-1
CONST. S-DRY
SPRUCE - PINE - FIR

Ontario Lumber Manufacturers Agency (OLMA)
244 Viau Road
Noelville, ON P0M 2N0

705.618.3403
fax: 705.898.3403
e-mail: aboucher@olma.ca

1. Approved as an inspection agency including mill supervisory service under:
   a. NLGA rules
   b. NGR and Section 6-Eastern White Pine Board Grades portions of the NeLMA rules
2. Approved to supervise glued and machine graded lumber.
3. Approved to provide heat treatment audit services under all rules.

PLIB® NLGA RULE
No 1
S-DRY
00 S — P — F

Pacific Lumber Inspection Bureau (PLIB)
British Columbia Division
P.O. Box 19118
Fourth Avenue Postal Outlet
Vancouver, BC V6K 4R8

BC tel/fax: 604.732.1782
US tel: 253.835.3344
e-mail: info@plib.org

1. Approval as an inspection agency including mill supervisory service under:
   a. NLGA rules
   b. WCLIB rules
   c. WWPA rules
   d. RIS rules
2. Approved to supervise glued and machine graded lumber.
3. Approved to provide heat treatment audit services under all rules.

S-P-F
1
000 S-DRY

Quebec Forest Industry Council (QFIC)
1175 Lavigerie Avenue, Suite 200
Ste-Foy, QB G1V 4P1

418.657.7916
fax: 418.657.3365
e-mail: info@cifq.qc.ca

1. Approved as an inspection agency including mill supervisory service under:
   a. NLGA rules
   b. NGR and paragraph 6.2 Commons portions of the NeLMA rules
2. Approved to supervise glued and machine graded lumber.
3. Approved to provide heat treatment audit services under all rules.

The following agencies are accredited to provide heat treatment service only. Typical stamps are shown.

0000 HT AWIS

American Wood Inspection Services (AWIS)
29767 CR250 540.558.8380
Carrollton, MO 64633 e-mail: brandon@heattreatinspections.com

1. Approval as an inspection agency including mill supervisory service under:
   a. Heat Treatment portion only of the NeLMA, NSLB, RIS, SPIB, WCLIB, WWPA, and NLGA rules

000 HT C IS Carolina Inspection Services Inc. 000 HT C IS

Carolina Inspection Services, Inc. (CIS)
5910 Morgan Park Dr. 866.753.5738
Monroe, NC 28110 704.624.1996
fax: 704.624.1946
e-mail: cis@carolinainspection.com

1. Approval as an inspection agency including mill supervisory service under:
   a. Heat Treatment portion only of the NeLMA, NSLB, RIS, SPIB, WCLIB, WWPA, and NLGA rules

C & R HT 000

Conway & Robison, LLC (C&R)
P.O. Box 1508 678.642.4036
Sharpsburg, GA 30277 e-mail: jason@cr-inspect.com

1. Approval as an inspection agency including mill supervisory service under:
   a. Heat Treatment portion only of the NeLMA, NSLB, RIS, SPIB, WCLIB, WWPA, and NLGA rules

EW PI 000 HT

Export Wood Packaging Inspection Service (EWPI)
1115 E Street 719.539.3123
Salida, CO 81201 877.400.7750
fax: 719.344.2353
e-mail: contact@exportwoodpi.com

1. Approval as an inspection agency including mill supervisory service under:
   a. Heat Treatment portion only of the NeLMA, NSLB, RIS, SPIB, WCLIB, WWPA, and NLGA rules

000

HT LIWP®

Lee Inspection & Consulting Services, Inc. (LIWP)
2207 California Plaza, #3B 800.508.6232
Bossier City, LA 71171 fax: 800.508.5531
e-mail: dkirk.stokes@gmail.com

1. Approval as an inspection agency including mill supervisory service under:
    a. Heat Treatment portion only of the NeLMA, NSLB, RIS, SPIB, WCLIB, WWPA, and NLGA rules

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HT MFPA

Missouri Forest Products Association (MFPA)
505 East State Street 573.634.3252
Jefferson City, MO 65101 fax: 573.636.2591
e-mail: moforest@moforest.org

1. Approval as an inspection agency including mill supervisory service under:
    a. Heat Treatment portion only of the NeLMA, NSLB, RIS, SPIB, WCLIB, WWPA, and NLGA rules

001

HT PRL®

000

HT PRL®

Package Research Laboratory (PRL)
41 Pine Street 973.627.4405
Rockaway, NJ 07866 fax: 973.627.4407
e-mail: ddixon@package-testing.com

1. Approval as an inspection agency including mill supervisory service under:
    a. Heat Treatment portion only of the NeLMA, NSLB, RIS, SPIB, WCLIB, WWPA, and NLGA rules

000 WRD HT

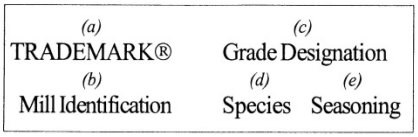
Wood Research and Development, LLC (WRD)
PO Box 70 541.752.0188
Jefferson, OR fax: 503.385.8493
e-mail: admin@woodrandd.com

1. Approval as an inspection agency including mill supervisory service under:
    a. Heat Treatment portion only of the NeLMA, NSLB, RIS, SPIB, WCLIB, WWPA, and NLGA rules

INTERPRETING GRADE STAMPS

With few exceptions (see note), all approved grade stamps include the following five elements:

Visually Graded Lumber [1]:



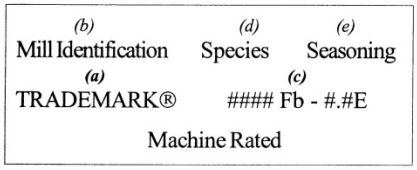
a. *Trademark* – indicates identity of agency quality supervision
b. *Mill Identification* – product manufacturer name, brand or assigned mill number
c. *Grade Designation* – grade name (number or abbreviation)
d. *Species Identification* – name or abbreviation of individual species or species combination
e. *Condition of Seasoning*[a] – moisture content classification at time of surfacing
   1. *S-Dry* – 19% maximum moisture content
   2. *MC15* – 15% maximum moisture content
   3. *KD* – kiln dried to moisture content indicated in grading rules
   4. *S-Grn* – over 19% moisture content (unseasoned)

[a] – *HT* – designation for Heat Treated - while not a seasoning designation, the abbreviation HT may be found in conjunction with the above seasoning abbreviations (see notes below). The HT definition can be found in the grading rules.

Machine Graded Lumber[1]:

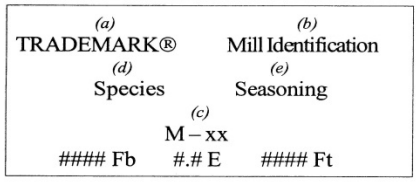
Grade stamps on machine graded lumber include the five elements listed above for visually graded lumber. Grade designations for the two types of machine grad lumber, machine stress rated (MSR) lumber and machine evaluated lumber (MEL), are distinctive from those used for visually graded lumber grades.

Machine Stress Rated Lumber (MSR) Stamp:



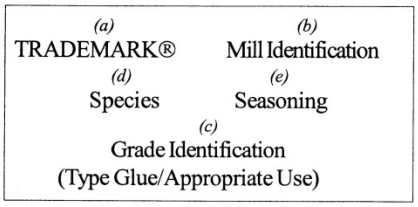
- MSR grade designations are composed of the assigned extreme fiber in bending (Fb or f) in psi and the assigned modulus of elasticity (E) in millions of pounds per square inch. Examples include 1650f-1.5E; 2100f-1.8E; and 2400f-2.0E.
- The phrase "Machine Rated" or "MSR" is also required on machine stress rated lumber stamps.

Machine Evaluated Lumber (MEL) Stamp:



- MEL grade designations use the format, M-xx; where xx indicates a one or two digit number. Examples include M-12; M-15; and M-19.
- In addition, the assigned extreme fiber in bending (Fb or f) in psi, the assigned modulus of elasticity (E) in millions of pounds per square inch, and the assigned tension parallel to grain (Ft) in psi are required elements on machine evaluated lumber stamps.

Glued Lumber[1]:



Grade stamps on glued lumber include all the information indicated for visually graded lumber. In addition, the grade stamp includes a designation or abbreviation indicating the type of glue joint and appropriate use. Examples include "Stud Use Only", "Vertical Use Only", "Certified End Joint", "Certified Exterior Joints", "Heat Resistant Adhesive", and "Non-heat Resistant Adhesive".

[1] Grade Stamp Layout – The placement of the required elements within a grade stamp may vary, depending on the preferences of the specific supervising agency. The sample grade stamp facsimiles that accompany the agency listing herein provide a good example of the typical placement of elements preferred by that particular agency. Contact the agency, whose trademark appears on the lumber, for specific information related to the agency's grade stamping policies.

Note: Grade stamps for timbers are not required to include the condition of seasoning.
An approved grade stamp may include only a) trademark, b) mill identification, c) HT designation.
Grade stamps are permitted to include information that is not required, so long as the additional information is not confusing, misleading or deceptive. Contact the agency, whose trademark appears on the lumber, for specific information related to the agency's grade stamping policy.

American Lumber Standard Committee, Incorporated
P.O. Box 210 Germantown, MD 20875-0210
301.972.1700 fax 301.540.8004 e-mail: alsc@alsc.org url: www.alsc.org

American Lumber Standard Committee, Incorporated

R.K. Caron, Chairman
T.F. Brodie, Vice Chairman
H.B. Sager, Treasurer
T.D. Searles, President

P.O. Box 210
Germantown, Maryland 20875-0210
Telephone: 301.972.1700
Fax: 301.540.8004
E-Mail: alsc@alsc.org

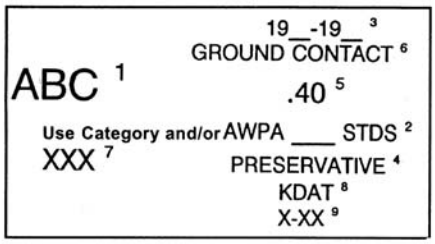
ACCREDITED AGENCIES FOR SUPERVISORY AND LOT INSPECTION OF PRESSURE TREATED WOOD PRODUCTS

July 2013

(this list supercedes all previous lists)

Agencies Accredited by the Board of Review of the American Lumber Standard Committee, Incorporated and Typical Quality Marks

Interpreting a Quality Mark



1 – The identifying symbol, logo, or name of the accredited agency.
2 – The applicable American Wood Protection Association (AWPA) standard and Use Category.
3 – The year of treatment if required by AWPA Standard/Use Category.
4 – The preservative used, which may be abbreviated.
5 – The preservative retention.
6 – The exposure category (e.g. Above Ground, Ground Contact, etc.).
7 – The company name and location of home office; or company name and number; or company number.
8 – If applicable, moisture content after treatment.
9 – If applicable, length, and/or class.

As specified below for particular agencies, some or all of the following American Wood Protection Association use-category standards are used by American Lumber Standard Committee, Incorporated accredited agencies which supervise facilities which pressure treat wood products:

Service Conditions for AWPA Use Category Designations

USE CATEGORY	SERVICE CONDITIONS	USE ENVIRONMENT	COMMON AGENTS OF DETERIORATION	TYPICAL APPLICATIONS
UC1 INTERIOR/ DRY	Interior construction Above Ground Dry	Continuously protected from weather or other sources of moisture	Insects only	Interior construction and furnishings
UC2 INTERIOR/ DAMP	Interior construction Above Ground Damp	Protected from weather, but may be subject to sources of moisture	Decay fungi and insects	Interior construction
UC3A ABOVE GROUND Protected	Exterior construction Above Ground Coated & rapid water runoff	Exposed to all weather cycles, not exposed to prolonged wetting	Decay fungi and insects	Coated millwork, siding and trim
UC3B ABOVE GROUND Exposed	Exterior construction Above Ground Uncoated or poor water run-off	Exposed to all weather cycles including prolonged wetting	Decay fungi and insects	Decking, deck joists, railings, fence pickets, uncoated millwork

Page 1 of 3

UC4A GROUND CONTACT General Use	**Ground Contact or Fresh Water Non-critical components**	Exposed to all weather cycles, normal exposure conditions	Decay fungi and insects	Fence, deck, and guardrail posts, crossties & utility poles (low decay areas)
UC4B GROUND CONTACT Heavy Duty	**Ground Contact or Fresh Water Critical components or difficult replacement**	Exposed to all weather cycles, high decay potential includes salt water splash	Decay fungi and insects with increased potential for biodeterioration	Permanent wood foundations, building poles, horticultural posts, crossties & utility poles (high decay areas)
UC4C GROUND CONTACT Extreme Duty	**Ground Contact or Fresh Water Critical structural components**	Exposed to all weather cycles, severe environments extreme decay potential	Decay fungi and insects with extreme potential for biodeterioration	Land & Freshwater piling, foundation piling, crossties & utility poles (severe decay areas)
UC5A MARINE USE Northern Waters	**Salt or brackish water and adjacent mud zone Northern waters**	Continuous marine exposure (salt water)	Salt water organisms	Piling, bulkheads, bracing
UC5B MARINE USE Central Waters	**Salt or brackish water and adjacent mud zone NJ to GA, south of San Francisco**	Continuous marine exposure (salt water)	Salt water organisms Including creosote tolerant *Limnoria tripunctata*	Piling, bulkheads, bracing
UC5C MARINE USE Southern Waters	**Salt or brackish water and adjacent mud zone South of GA, Gulf Coast, Hawaii, and Puerto Rico**	Continuous marine exposure (salt water)	Salt water organisms Including *Martesia, Sphaeroma*	Piling, bulkheads, bracing

*** For additional information concerning the AWPA Use Category treatment requirements contact the American Wood Protection Association, P.O. Box 361784, Birmingham, AL 35236-1784 (Telephone 205.733.4077, Fax 205.733.4075, e-mail: email@awpa.com, url: www.awpa.com).

As specified in the following tables, some or all of the following preservatives are used:

CCA	- chromated copper arsenate
ACZA	- ammoniacal copper zinc arsenate
ACC	- acid copper chromate
ACQ	- alkaline copper quat.
CuN	- copper nahpthenate
PCP	- pentachlorophenol
CR	- creosote and/or solutions
SBX	- borates
CA	- copper azole
CX	-copper HDO
KDS	-alkaline copper betaine
EL2	-DCOI + Imidacloprid
PTI	-propiconazole tebuconazole imidacloprid

KEY TO THE FOLLOWING TABLES

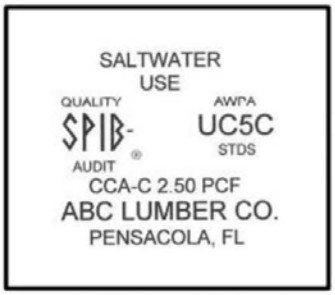
1	- sawn material and plywood
2	- plywood only
3	- sawn material only
R	- round commodities
SP	- southern pine
RP	- red pine
PP	- ponderosa pine
HF	- hem-fir
DF	- coastal Douglas fir
LP	- lodgepole pine
WH	- western hemlock
RDP	- radiata pine
CP	- caribbean pine
EWP	- eastern white pine
JP	- jack pine

ACCREDITED AGENCY AND ADDRESSES | TYPICAL QUALITY MARK | TABLE OF COMMODITIES, BY SPECIES AND PRESERVATIVE (see key)

Bode Inspection, Inc.
P.O. Box 307
Beaverton, OR 97075-0307
503.590.3555
503.590.2802 (f)
e-mail: bodeins@comcast.net

	HF	DF	WH
CCA	1	1,R	R
ACZA	1	1,R	R
ACC	1	1,R	R
ACQ	1	1,R	
CuN	1	1,R	R
PCP	1	1,R	R
CR	1	1,R	R
CA	3	1	3
SBX	1	1	1

Southern Pine Inspection Bureau
4555 Spanish Trail
Pensacola, FL 32504
850.434.5011
850.434.5388 (f)
e-mail: spib@spib.org



ALL AWPA APPLICABLE SPECIES	
CCA	1,R
PCP	R
CR	R
ACQ	1
ACZA	1
ACC	1
SBX	1
CA	1,R

Southern Pine Inspection Bureau maintains a laboratory accredited for the analysis of wood samples pressure treated with the following preservative(s): CCA, ACC, ACZA, SBX, PCP, CR, CA, and ACQ.

Timber Products Inspection
P.O. Box 919
Conyers, GA 30012
770.922.8000
770.922.1290 (f)
e-mail: jwilliams@tpinspection.com

ALL AWPA APPLICABLE SPECIES	
CCA	1,R
ACZA	1,R
ACC	1,R
ACQ	1,R
CuN	1,R
PCP	1,R
CR	1,R
SBX	1
CA	1,R

Timber Products Inspection maintains a laboratory accredited for the analysis of wood samples pressure treated with the following preservative(s): CCA, ACZA, ACC, ACQ, CuN, PCP, CR, SBX, and CA.

American Lumber Standard Committee, Incorporated
P.O. Box 210 Germantown, MD 20875-0210
301.972.1700 fax 301.540.8004 e-mail: alsc@alsc.org url: www.alsc.org

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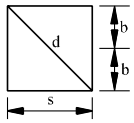
AREAS OF PLANE FIGURES

Square



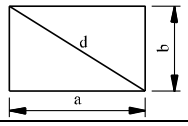
Diagonal = d = $s\sqrt{2}$

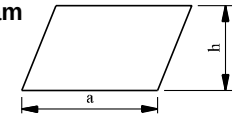
Area = $s^2 = 4b^2 = 0.5d^2$

Example: s = 6; b = 3; Area = $(6)^2$ = 36 Ans.

d = 6 x 1.414 = 8.484 Ans.

Rectangle and Parallelogram



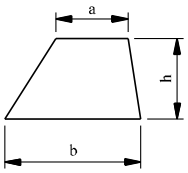


Area = ab or $b\sqrt{d^2 - b^2}$

Example. a = 6; b = 3.

Area = 3 x 6 = 18 Ans.

Trapezoid

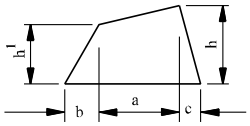


Area = $\frac{1}{2}h(a+b)$

Example: a = 2; b = 4; h = 3

Area = $\frac{1}{2} \times 3(2+4) = 9$ Ans.

Trapezium



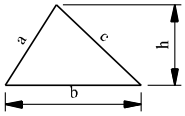
Area = $\frac{1}{2}\left[a\left(h+h^1\right)+bh^1+ch\right]$

Example: a = 4; b = 2; c = 2; h = 3; h^1 = 2.

Area = $\frac{1}{2}\left[4(3+2)+(2\times 2)+(2\times 3)\right] = 15$ Ans.

Triangles

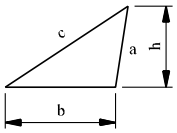
Both formulas apply to both figures.



Area = $\frac{1}{2}$ bh

Example: h =3; b = 5

Area = $\frac{1}{2}(3\times 5) = 7\frac{1}{2}$ Ans.

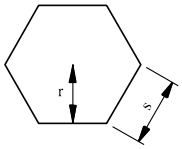


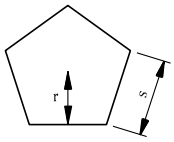
Area = $\sqrt{S(S-a)(S-b)(S-c)}$ where S = $\frac{a+b+c}{2}$

Example: a = 2; b = 3; c = 4

S = $\frac{2+3+4}{2}$ = 4.5; Area = $\sqrt{4.5(4.5-2)(4.5-3)(4.5-4)}$ = 2.9 Ans.

Regular Polygons





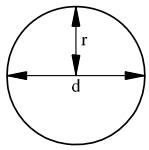
$$\text{Area}\left\{\begin{array}{l} 5\text{ sides} = 1.720477\,S^2 = 3.63271\,r^2 \\ 6\text{ sides} = 2.598150\,S^2 = 3.46410\,r^2 \\ 7\text{ sides} = 3.633875\,S^2 = 3.37101\,r^2 \\ 8\text{ sides} = 4.828427\,S^2 = 3.31368\,r^2 \\ 9\text{ sides} = 6.181875\,S^2 = 3.27573\,r^2 \\ 10\text{ sides} = 7.694250\,S^2 = 3.24920\,r^2 \\ 11\text{ sides} = 9.365675\,S^2 = 3.22993\,r^2 \\ 12\text{ sides} = 11.196300\,S^2 = 3.21539\,r^2 \end{array}\right.$$

n = number of sides; r = short radius; S = length of side; R = long radius.

Area = $\frac{n}{4}S^2\cot.\frac{180°}{n} = \frac{n}{2}R^2\sin.\frac{360°}{n} = nr^2\tan\frac{180°}{n}$

AREAS OF PLANE FIGURES

Circle



π = 3.1416; A = area; d = diameter

p = circumference or periphery; r = radius

$p = \pi d = 3.1416d$ $\qquad$ $p = 2\sqrt{\pi A} = 3.54\sqrt{A}$

$p = 2\pi r = 6.2832r$ $\qquad$ $p = \frac{2A}{r} = \frac{4A}{d}$

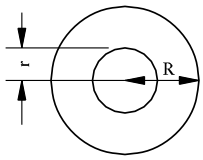
$d = \frac{p}{\pi} = \frac{p}{3.1416}$ $\qquad$ $d = 2\sqrt{\frac{A}{\pi}} = 1.128\sqrt{A}$

$r = \frac{p}{2\pi} = \frac{p}{6.2832}$ $\qquad$ $r = \sqrt{\frac{A}{\pi}} = 0.564\sqrt{A}$

$A = \frac{\pi d^2}{4} = 0.7854d^2$ $\qquad$ $A = \frac{p^2}{4\pi} = \frac{p^2}{12.57}$

$A = \pi r^2 = 3.1416r^2$ $\qquad$ $A = \frac{pr}{2} = \frac{pd}{4}$

Circular Ring



Area = $\pi\left(R^2 - r^2\right) = 3.1416\left(R^2 - r^2\right)$

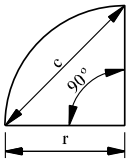
Area = $0.7854(D^2-d^2) = 0.7854(D-d)(D+d)$

Area = difference in areas between the inner and outer circles.

Example: R = 4; r = 2.

Area = $3.1416(4^2-2^2) = 37.6992$ Ans.

Quadrant

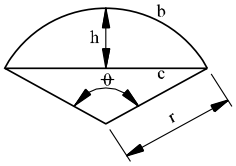


Area = $\frac{\pi r^2}{4} = 0.7854r^2 = 0.3927c^2$

Example. r = 3; c = chord.

Area = $0.7851 \times 3^2 = 7.0686$ Ans.

Segment



b = length of arc; θ = angle in degrees; c = chord = $\sqrt{4\left(2hr - h^2\right)}$

Area = $\frac{1}{2}\left[br - c\left(r - h\right)\right] = \pi r^2 \frac{\theta}{360} - \frac{c\left(r - h\right)}{2}$

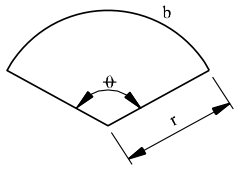
When θ is greater than 180° then $\frac{c}{2} \times$ difference between r and h is added to the fraction $\frac{\pi r^2 \theta}{360}$.

Example: r = 3; θ = 120°; h = 1.5

Area = $3.1416 \times 3^2 \times \frac{120}{360} - \frac{5.196\left(3 - 1.5\right)}{2} = 5.5278$ Ans.

AREAS OF PLANE FIGURES

Sector



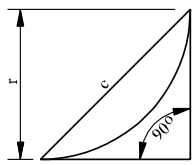
Area = $\frac{br}{2} = \pi r^2 \frac{\theta}{360°}$

θ = angle in degrees; b = length of arc

Example: r = 3; θ = 120°

Area = 3.1416 $\times 3^2 \times \frac{120}{360} = 9.4248$ Ans.

Spandrel



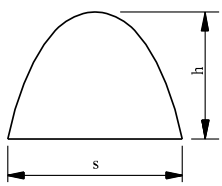
Area = $0.2146r^2 = 0.1073c^2$

Example: r = 3

Area = $0.2146 \times 3^2 = 1.9314$ Ans.

Parabola

l = length of curved line = periphery – s



$$l = \frac{s^2}{8h}\left[\sqrt{c(1+c)} + 2.0326 \times \log\left(\sqrt{c} + \sqrt{1+c}\right)\right] \text{ where } c = \left(\frac{4h}{s}\right)^2$$

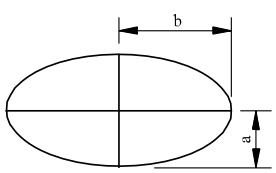
Area = $\frac{2}{3}sh$

Example: s = 3; h = 4

Area = $\frac{2}{3} \times 3 \times 4 = 8$ Ans.

Ellipse

Area = $\pi ab = 3.1416ab$



Circum. = $2\pi\sqrt{\frac{a^2 + b^2}{2}}$ (close approximation)

Example. a = 3; b = 4.

Area = 3.1416 x 3 x 4 = 37.6992 Ans.

Circum. = 2 x 3.1416 $\sqrt{\frac{(3)^2 + (4)^2}{2}} = 6.2832 \times 3.5355$ = 22.21 Ans.

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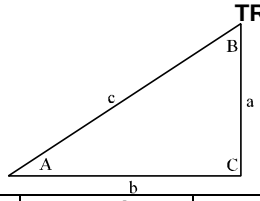
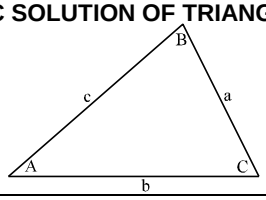
TRIGONOMETRIC SOLUTION OF TRIANGLES





$$S = \frac{a + b + c}{2}$$

Given:	Sought:	Formulae:
RIGHT-ANGLED TRIANGLES		
a,c	A,B,b	$\sin A = \frac{a}{c}$, $\cos B = \frac{a}{c}$, $b = \sqrt{c^2 - a^2}$
	Area	Area = $\frac{a}{2}\sqrt{c^2 - a^2}$
a,b	A,B,c	$\tan A = \frac{a}{b}$, $\tan B = \frac{b}{a}$, $c = \sqrt{a^2 + b^2}$
	Area	Area = $\frac{ab}{2}$
A,a	B,b,c	B = 90° - A, b = a cot A, $c = \frac{a}{\sin A}$
	Area	Area = $\frac{a^2 \cot A}{2}$
A,b	B,a,c	B = 90° - A, a = b tan A, $c = \frac{b}{\cos A}$
	Area	Area = $\frac{b^2 \tan A}{2}$
A,c	B,a,b	B = 90° - A, a = c sin A, b = c cos A
	Area	Area = $\frac{c^2 \sin A \cos A}{2}$ or $\frac{c^2 \sin 2A}{4}$
OBLIQUE-ANGLED TRIANGLES		
a,b,c	A	$\sin \frac{1}{2} A = \sqrt{\frac{(s-b)(s-c)}{bc}}$, $\cos \frac{1}{2} A = \sqrt{\frac{s(s-2)}{bc}}$, $\tan \frac{1}{2} A = \sqrt{\frac{(s-b)(s-c)}{s(s-a)}}$
	B	$\sin \frac{1}{2} B = \sqrt{\frac{(s-a)(s-c)}{ac}}$, $\cos \frac{1}{2} B = \sqrt{\frac{s(s-b)}{ac}}$, $\tan \frac{1}{2} B = \sqrt{\frac{(s-a)(s-c)}{s(s-b)}}$
	C	$\sin \frac{1}{2} C = \sqrt{\frac{(s-a)(s-b)}{ab}}$, $\cos \frac{1}{2} C = \sqrt{\frac{s(s-c)}{ab}}$, $\tan \frac{1}{2} C = \sqrt{\frac{(s-a)(s-b)}{s(s-c)}}$
	Area	Area = $\sqrt{s(s-a)(s-b)(s-c)}$
a,A,B	b,c	$b = \frac{a \sin B}{\sin A}$ $c = \frac{a \sin C}{\sin A} = \frac{a \sin(A+B)}{\sin A}$
	Area	Area = $\frac{1}{2} a b \sin C = \frac{a^2 \sin B \sin C}{2 \sin A}$

TRIGONOMETRIC SOLUTION OF TRIANGLES

a,b,A	B	$\sin B = \dfrac{b \sin A}{a}$
	c	$c = \dfrac{a \sin C}{\sin A} = \dfrac{b \sin C}{\sin B} = \sqrt{a^2 + b^2 - 2ab\cos C}$
	Area	Area = $\dfrac{1}{2}$ ab sin C
a,b,C	A	$\tan A = \dfrac{a \sin C}{b - a\cos C}$, $\tan \dfrac{1}{2}(A - B) = \dfrac{a - b}{a + b} \cot \dfrac{1}{2} C$
	c	$c = \sqrt{a^2 \div b^2 - 2ab\cos C} = \dfrac{a \sin C}{\sin A}$
	Area	Area = $\dfrac{1}{2}$ ab sin C
$a^2 = b^2 + c^2 - 2bc \cos A$, $b^2 = a^2 + c^2 - 2ac \cos B$, $c^2 = a^2 + b^2 - 2ab \cos C$		

PROBABLE COMPRESSIVE STRENGTH OF CONCRETE CYLINDERS

$$S^{28} = S^{7} + 30\sqrt{S^{7}}$$

where: S^{28} = approximate 28 day strength.

S^{7} = known 7 day strength.

For approximating strengths at other ages from known strengths at various ages the following table may be used.

AGE (days)	PROBABLE COMPRESSIVE STRENGTH (pounds per square inch)								
100	1550	2250	2900	4150	4720	5400	5970	6560	
90	1500	2180	2830	3440	4050	4620	5280	5840	6430
80	1460	2110	2740	3350	3950	4510	5150	5710	6290
70	1390	2030	2640	3250	3830	4380	5000	5550	6110
60	1330	1940	2540	3120	3690	4220	4840	5370	5930
55	1290	1890	2470	3050	3610	4140	4750	5270	5820
50	1250	1840	2410	2970	3520	4050	4640	5170	5700
45	1200	1780	2330	2890	3420	3950	4520	5040	5570
40	1150	1700	2250	2790	3310	3830	4400	4910	5430
38	1130	1670	2220	2760	3280	3790	4350	4860	5380
36	1110	1640	2190	2720	3230	3740	4300	4800	5310
34	1080	1610	2140	2670	3180	3680	4220	4720	5240
32	1050	1580	2100	2620	3120	3620	4160	4650	5170
30	1030	1540	2050	2560	3060	3560	4090	4570	5090
28	1000	1500	2000	2500	3000	3500	4000	4500	5000
26	960	1450	1950	2450	2930	3410	3930	4400	4900
24	920	1400	1890	2380	2850	3340	3840	4300	4800
22	890	1350	1830	2310	2780	3250	3750	4200	4700
20	850	1300	1770	2240	2700	3160	3640	4100	4590
19	830	1270	1730	2200	2650	3110	3590	4040	4510
18	800	1240	1690	2150	2600	3050	3520	3980	4450
17	780	1200	1650	2100	2550	3000	3460	3910	4380
16	750	1170	1600	2050	2490	2940	3400	3830	4300
15	720	1130	1550	2000	2430	2870	3310	3770	4210
14	690	1090	1500	1950	2360	2800	3250	3690	4130
13	660	1050	1450	1890	2300	2740	3180	3600	4050
12	630	1000	1400	1820	2230	2660	3090	3500	3960
11	590	950	1350	1750	2150	2570	3000	3400	3850
10	550	900	1280	1680	2070	2490	2900	3300	3730
9	510	840	1200	1590	1980	2380	2780	3170	3600
8	460	780	1130	1500	1880	2280	2650	3050	3460
7	400	700	1040	1380	1750	2120	2500	2890	3280
6	340	600	920	1260	1610	1980	2340	2700	3100

CONVERSION TABLES

MULTIPLY	BY	TO OBTAIN
ACRES	43560	SQUARE FEET
BARRELS OF CEMENT	376	POUNDS OF CEMENT
BAGS OF CEMENT	94	POUNDS OF CEMENT (1 CU FT)
CUBIC FEET	7.48052	U.S. GALLONS
CUBIC FEET	1728	CUBIC INCHES
CUBIC FEET	62.4	POUNDS OF WATER
CUBIC INCHES	0.0005787	CUBIC FEET
CUBIC INCHES	0.004329	U.S. GALLONS
CUBIC YARDS	27	CUBIC FEET
CUBIC YARDS	46656	CUBIC INCHES
CUBIC YARDS	201.97	U.S. GALLONS
FATHOMS	6	FEET
FEET	0.3048	METERS
FEET PER SECOND	0.68182	MILES PER HOUR
METERS	3.281	FEET
METERS	39.37	INCHES
METERS	1.094	YARDS
MILES	5280	FEET
MILES PER HOUR	88	FEET PER MINUTE
MILES PER HOUR	1.46667	FEET PER SECOND
POUNDS OF WATER	0.01602	CUBIC FEET
POUNDS OF WATER	27.68	CUBIC INCHES
POUNDS OF WATER	0.12	U.S. GALLONS
SQUARE FEET	144	SQUARE INCHES
SQUARE MILES	640	ACRES
SQUARE YARDS	9	SQUARE FEET
SQUARE FEET	0.0002066	ACRES
TONS (SHORT)	2000	POUNDS
TONS (LONG)	2240	POUNDS

CONVERSION FACTORS
LENGTH MEASUREMENTS

UNITS	INCHES	FEET	YARDS	RODS	MILES	METERS
1 Inch	1	0.08333	0.027778	0.005051	0.0000157828	0.0254
1 Foot	12	1	0.3333	0.060606	0.00018939	0.304801
1 Yard	36	3	1	0.181818	0.000568182	0.914402
1 Rod	198	16.5	5.5	1	0.003125	5.029216
1 Mile (Stat)	63360	5280	1760	320	1	1609.347
1 Meter	39.37	3.280833	1.093611	0.198838	0.00062137	1
1 Link	7.92	0.66	0.22	0.04	0.000125	0.201168
1 Chain	792	66	22	4	0.0125	20.177
1 Station	1200	100	33.33	6.060606	0.0189394	30.4801
1 Furlong	7920	660	220	40	0.125	201.168
1 Mile (Naut)	72913	6076.103	2025.366	368.248	1.15078	1852
1 Millimeter	0.03937	0.003281	0.001094	0.000199	--	0.001
1 Centimeter	0.3937	0.032808	0.010936	0.001988	--	0.01
1 Kilometer	--	3280.833	1093.611	198.836	0.621370	1000

CONVERSION MEASUREMENTS
WEIGHT MEASUREMENTS

UNITS	OUNCES	POUNDS	TONS (SHORT)	TONS (LONG)	KILOGRAMS	TONS (METRIC)
1 OUNCE	1	0.0625	---	---	0.028349	---
1 POUND	16	1	0.0005	0.0004464	0.4535924	0.00045359
1 TON (SHORT)	32000	2000	1	0.892857	907.18486	0.907185
1 TON (LONG)	35840	2240	1.12	1	1016.047	1.016047
1 KILOGRAM	35.27396	2.204622	0.0011023	0.0009842	1	0.001
1 TON (METRIC)	35273.96	2204.62	1.10231	0.98421	1000	1
1 HNDRDWEIGHT (SHORT)	1600	100	0.05	0.044643	45.3592	0.045359
1 HNDRDWEIGHT (LONG)	1792	112	0.056	0.05	50.8023	0.050802
1 GRAIN	0.0022857	---	---	---	---	---
1 GRAM	0.0352739	0.002204	---	---	0.001	---
1 MILLIGRAM	---	---	---	---	0.000001	---

CONVERSION FACTORS
AREA MEASUREMENTS

UNITS	SQUARE INCHES	SQUARE FEET	SQUARE YARDS	SQUARE RODS	ACRES	SQUARE MILES	SQUARE METERS
1 SQUARE INCH	1	0.006944	0.0007716	---	---	---	0.00064516
1 SQUARE FOOT	144	1	0.11111	0.0036731	---	---	0.09290341
1 SQUARE YARD	1296	9	1	0.033058	0.0002066	---	0.8361307
1 SQUARE ROD	39204	272.25	30.25	1	0.00625	---	25.29295
1 ACRE	---	43560	4840	160	1	0.0015625	4046.873
1 SQUARE MILE	---	---	3097600	102400	640	1	2589998
1 SQUARE METER	1550	10.76387	1.195985	0.0395367	0.0002471	---	1
1 SQUARE LINK	62.7264	0.4356	0.0484	0.0016	0.00001	---	0.040468
1 SQUARE CHAIN	627264	4356	484	16	0.1	---	404.689
1 SQUARE	14400	100	11.1111	0.367309	0.0022956	---	9.29034
1 SECTION	---	---	3097600	102400	640	1	2589998
1 SQUARE CENTIMETER	0.1549997	0.0010764	0.0001196	---	---	---	0.0001
1 HECTARE	---	107638.7	11959.85	395.367	2.471044	0.003861	10000
1 SQUARE KILOMETER	---	---	1195985	39536.7	247.1044	0.3861006	1000000

CONVERSION FACTORS
VOLUME MEASUREMENTS

UNITS	CUBIC INCHES	CUBIC FEET	CUBIC YARDS	PINTS (LIQUID)	QUARTS (LIQUID)	GALLONS (U.S.)	LITERS (1000 cc)
1 CUBIC INCH	1	0.000579	0.0000214	0.034632	0.017316	0.004329	0.016387
1 CUBIC FOOT	1728	1	0.037037	59.844	29.922	7.4805	28.31625
1 CUBIC YARD	46656	27	1	1615.8	807.9	201.975	764.54
1 PINT (LIQUID)	28.875	0.016710	0.000619	1	0.5	0.125	0.473168
1 QUART (LIQUID)	57.75	0.033420	0.001238	2	1	0.25	0.946333
1 GALLON (U.S.)	231	0.1336805	0.004951	8	4	1	3.78533
1 LITER (1000 cc)	61.025	0.035316	0.001308	2.11336	1.056682	0.264178	1
1 GILL	7.21876	0.004177	0.000155	0.25	0.125	0.03125	0.118292
1 PINT (DRY)	33.6003	0.019445	0.000720	1.163647	0.581823	0.145456	0.550599
1 QUART (DRY)	67.200625	0.038889	0.001440	2.32730	1.163646	0.290912	1.10120
1 QUART (IMPERIAL)	69.35503	0.040135	0.001486	2.4019	1.200953	0.300238	1.13650
1 GALLON (IMPERIAL)	277.4201	0.16054	0.0059457	9.60762	4.80381	1.20095	4.54609
1 PECK	537.605	0.311114	0.011523	18.61835	9.309177	2.327294	8.809586
1 BUSHEL (U.S.)	2150.42	1.2444	0.046089	74.47341	37.23670	9.3092	35.238329
1 BOARD FOOT	144	0.08333	0.003086	4.987012	2.493506	0.623376	2.3597
1 CORD	221184	128	4.74074	7660.051	3830.025	957.506	3624.48
1 PERTROLEUM BARREL	9701.975	5.614569	0.207947	336	168	42	158.9839
1 BARREL (U.S. LIQUID)	7276.370	4.21086	0.15596	252	126	31.5	119.237895
1 CUBIC METER	61023.38	35.314445	1.307943	2113.4	1056.7	264.178	999.973
1 CUBIC CENTIMETER	0.061024	0.0000353	---	0.002113	0.001057	0.0002642	0.000999

EQUIVALENT WEIGHTS OF AGGREGATES

POUNDS PER CUBIC FOOT	POUNDS PER CUBIC YARD	TONS PER CUBIC YARD	CUBIC YARDS PER TON	POUNDS PER CUBIC FOOT	POUNDS PER CUBIC YARD	TONS PER CUBIC YARD	CUBIC YARDS PER TON
60	1620	0.81	1.23	94.4	2550	1.28	0.78
65	1755	0.88	1.14	96.3	2600	1.30	0.77
70	1890	0.95	1.06	98.1	2650	1.33	0.75
75	2025	1.01	0.99	100.0	2700	1.35	0.74
80	2160	1.08	0.93	101.9	2750	1.38	0.73
85	2295	1.15	0.87	103.7	2800	1.40	0.71
90	2430	1.22	0.82	105.6	2850	1.43	0.70
95	2565	1.28	0.78	107.4	2900	1.45	0.69
100	2700	1.35	0.74	109.3	2950	1.48	0.68
105	2835	1.42	0.71	111.1	3000	1.50	0.67
110	2970	1.49	0.67	113.0	3050	1.53	0.66
115	3105	1.55	0.64	114.8	3100	1.55	0.65
120	3240	1.62	0.62	116.7	3150	1.58	0.63
125	3375	1.69	0.59	118.5	3200	1.60	0.63
130	3510	1.76	0.57	120.4	3250	1.63	0.62
135	3645	1.82	0.55	122.2	3300	1.65	0.61
140	3780	1.89	0.53	124.1	3350	1.68	0.60
66.7	1800	0.90	1.11	125.9	3400	1.70	0.59
68.5	1850	0.93	1.08	127.8	3450	1.73	0.58
70.4	1900	0.95	1.05	129.6	3500	1.75	0.57
72.2	1950	0.97	1.03	131.5	3550	1.78	0.56
74.1	2000	1.00	1.00	133.3	3600	1.80	0.56
75.9	2050	1.03	0.98	135.2	3650	1.83	0.55
77.8	2100	1.05	0.85	137.0	3700	1.85	0.54
79.6	2150	1.08	0.93	138.0	3750	1.88	0.53
81.5	2200	1.10	0.91	140.7	3800	1.90	0.52
83.3	2250	1.13	0.89	142.6	3850	1.93	0.52
85.2	2300	1.15	0.87	144.4	3900	1.95	0.51
87.0	2350	1.18	0.85	146.3	3950	1.98	0.51
88.9	2400	1.20	0.83	148.1	4000	2.0	0.50
90.7	2450	1.23	0.82	150.0	4050	2.03	0.49
92.6	2500	1.25	0.80				

TEMPERATURE-VOLUME CORRECTIONS FOR EMULSIFIED ASPHALTS

Legend: t = observed temperature in degrees Celsius (Fahrenheit)
M = multiplier for correcting volumes to the basis of 15.6°C (60°F)

t °C	°F	M*	t °C	°F	M*	t °C	°F	M*
10.0	50	1.00250	35.0	95	.99125	57.8	136	.98100
10.6	51	1.00225	35.6	96	.99100	58.3	137	.98075
11.1	52	1.00200	36.1	97	.99075	58.9	138	.98050
11.7	53	1.00175	36.7	98	.99050	59.4	139	.98025
12.2	54	1.00150	37.2	99	.99025	60.0	140	.98000
12.8	55	1.00125	37.8	100	.99000	60.6	141	.97975
13.3	56	1.00100	38.3	101	.98975	61.1	142	.97950
13.9	57	1.00075	38.9	102	.98950	61.7	143	.97925
14.4	58	1.00050	39.4	103	.98925	62.2	144	.97900
15.0	59	1.00025	40.0	104	.98900	62.8	145	.97875
15.6	60	1.00000	40.6	105	.98875	63.3	146	.97850
16.1	61	.99975	41.1	106	.98850	63.9	147	.97825
16.7	62	.99950	41.7	107	.98825	64.4	148	.97800
17.2	63	.99925	42.2	108	.98800	65.0	149	.97775
17.8	64	.99900	42.8	109	.98775	65.6	150	.97750
18.3	65	.99875	43.3	110	.98750	66.1	151	.97725
18.9	66	.99850	43.9	111	.98725	66.7	152	.97700
19.4	67	.99825	44.4	112	.98700	67.2	153	.97675
20.0	68	.99800	45.0	113	.98675	67.8	154	.97650
20.6	69	.99775	45.6	114	.98650	68.3	155	.97625
21.1	70	.99750	46.1	115	.98625	68.9	156	.97600
21.7	71	.99725	46.7	116	.98600	69.4	157	.97575
22.2	72	.99700	47.2	117	.98575	70.0	158	.97550
22.8	73	.99675	47.8	118	.98550	70.6	159	.97525
23.3	74	.99650	48.3	119	.98525	71.1	160	.97500
23.9	75	.99625	48.9	120	.98500	71.7	161	.97475
24.4	76	.99600	49.4	121	.98475	72.2	162	.97450
25.0	77	.99575	50.0	122	.98450	72.8	163	.97425
25.6	78	.99550	50.6	123	.98425	73.3	164	.97400
26.1	79	.99525	51.1	124	.98400	73.9	165	.97375
26.7	80	.99500	51.7	125	.98375	74.4	166	.97350
27.2	81	.99475	52.2	126	.98350	75.0	167	.97325
27.8	82	.99450	52.8	127	.98325	75.6	168	.97300
28.3	83	.99425	53.3	128	.98300	76.1	169	.97275
28.9	84	.99400	53.9	129	.98275	76.7	170	.97250
29.4	85	.99375	54.4	130	.98250	77.2	171	.97225
30.0	86	.99350	55.0	131	.98225	77.8	172	.97200
30.6	87	.99325	55.6	132	.98200	78.3	173	.97175
31.1	88	.99300	56.1	133	.98175	78.9	174	.97150
31.7	89	.99275	56.7	134	.98150	79.4	175	.97125
32.2	90	.99250	57.2	135	.98125			
32.8	91	.99225						
33.3	92	.99200						
33.9	93	.99175						
34.4	94	.99150						

*Multiplier (M) for °C is a close approximation.