TABLE 2. PERMEANCE AND PERMEABILITY OF MATERIALS TO WATER VAPOR

MATERIAL	PERMEANCE PERM	PERMEABILITY PERM-INCH	% RH_1-RH_2	METHOD†	REF.‡
AIR (still)		120.	92-73	b	3
INSULATION					
Cellular glass		0.0		d	
Corkboard		2.1-2.6	75-0	d	6
Corkboard		9.5	100-45	w	9
Structural Insulating Board (vegetable, uncoated)		20-50	40-x	t	7
Mineral Wool (unprotected)		116.	100-30	w	4
WOOD					
Sugar Pine (see Fig. 2)		0.4-5.4	various	tv	3
Plywood (Exterior type 3 ply D.F.), ¼ in.	0.72		50-	4	11
Plywood (Interior type 3 ply D.F.), ¼ in.	1.86		50-	4	11
MASONRY					
Concrete (1:2:4 Mix)		3:2	100-45	w	9
Concrete (8" cored block wall, limestone agrgt.)	2.4		79-68	t	3
Brick wall—with mortar—4 in.	0.8		50-x	t	8
Tile wall—with mortar—4 in.	0:12		50-x	t	8
INTERIOR FINISH					
Plaster on wood lath	11.		100-30	w	4
Plaster on metal lath—¾"	15.		40-x	t	7
Plaster on plain gypsum lath (with studs)	20.		40-85	t	3
Gypsum wall board—plain—⅜ in.	50.		50-20	v	13
Insulating wall board (uncoated)—½ in.	50-90		40-x	t	7
* PAINT—2 coats					
Asphaltic paint on plywood	0.4		100-30	w	4
Aluminum in varnish on wood	0.3-0.5		95-0	d	10
Enamels, brushed on smooth plaster	0.5-1.5		92-0	b	3
Primers or *Sealers* on insulating wall board	0.9-2.1		40-x	t	7
Various *Primers* + 1 coat flat paint on plaster	1.6-3.		40-x	t	7
Flat paint (alone) on insulating wall board	4.		40-x	t	7
Water Emulsions on insulating wall board	30.-85.		40-x	t	7
* PAINT—Exterior, 3 coats					
White *lead & oil* prepared paint on wood siding	0.3-1.0		50-0	d	13
White lead-zinc oxide & linseed oil on wood	0.9		95-0	d	10

	Lb. per 500 sq ft	PERMEANCE-PERMS dry cup	PERMEANCE-PERMS wet cup	
* BUILDING PAPERS AND FELTS				
Duplex sheet, asphalt laminae, *aluminum foil* one side	43	0.002	0.176	12
Saturated and *coated* felt heavy roll roofing	326	0.05	0.24	12
Kraft and *asphalt laminae*, Reinforced 30-120-30	34	0.3	1.8	12
Insulation back up, asphalt-sat., one side glossy	21	0.4	0.6-4.2	12
Asphalt-saturated and coated sheathing paper	43	0.3	0.6	12
Asphalt-saturated sheathing paper	22	3.3	20.2	12
15-pound asphalt felt	70	1.0	5.6	12
15-pound tar felt	70	4.0	18.2	12
Single sheet Kraft, double infused	16	30.8	41.9	12

* Description is a guide only, and does not insure permeance.

† Methods: d—dry cup; w—wet cup; t—two temperatures; b—special cell; v—air velocity both sides; 4—average of four methods.

‡ References. No. 7 also includes *Bulletins* 22 and 25 of the *Engineering Experiment Station, University of Minnesota*. No. 13 includes data to be published by the *Engineering Experiment Station, The Pennsylvania State College*.

building materials showing, in each case, the source and method and, where applicable, the thickness tested.

Water-proofed building papers are listed in *Federal Specifications* UU-P-147, May 24, 1948, according to water vapor resistance required as:

Class A. For uses where a high degree of water vapor resistance is required.
Class B. For uses where a lower degree of water vapor resistance and of water resistance is required.
Class C. For uses where a moderate degree of water resistance is required.
Class D. For uses where low resistance to water vapor is required.

It may be noted that a paper may be *water-proof, i.e.* possess water resistance, and still have low water vapor resistance.

Detail requirements in these specifications are given as follows, the specified WVT Test being a dry method at 73 F:

Class A paper shall have a minimum tensile strength in each direction of either 35 lb per inch width, or 20 lb per inch width, as specified in the invitation for bids. Paper of both strengths shall have a minimum water resistance of 24 hr, and a maximum water vapor permeability (WVT) of 4 grams per square meter per 24 hr, (i.e. 0.576 perm).

Class B paper shall have a minimum tensile strength in each direction of either 35 lb per inch width, or 20 lb per inch width, as specified in the invitation for bids. Paper of both strengths shall have a minimum water resistance of 16 hr, and a maximum water vapor permeability (WVT) of 6 grams per square meter per 24 hr, (i.e. 0.864 perm).

Class C paper shall have a minimum tensile strength in each direction of either 35 lb per inch width, or 20 lb per inch width, as specified in the invitation for bids. Paper of both strengths shall have a minimum water resistance of 8 hr.

Class D paper shall have a minimum tensile strength in each direction of 20 lb per inch width. The paper shall have a minimum water resistance of 10 min., a minimum water vapor permeability (WVT) of 35 grams per square meter per 24 hr, (i.e. 5.04 perms).

CONCEALED CONDENSATION IN HEATED BUILDINGS

Water vapor produced in a building necessarily raises the vapor pressure above that outside thus providing the force that causes its diffusion into exterior walls. The amount of vapor pressure rise in the building depends on the amount of vapor produced and inversely on its chance to escape. The resulting balance may be expressed in terms of relative humidity if the inside temperature is 70 F. The relative humidity in heated buildings covers nearly all of the possible range. In zero weather it may be only 10 percent in an office, and 85 percent in an industrial plant where humidification is required for a process, or where vapor release is incidental to a process. In residences the relative humidity in cold winter weather ranges from 10 percent to 60 percent, the latter figure applying to a very small, crowded and unventilated dwelling. A 40 percent level is considered representative of a substantial number of modern tightly constructed small houses although the average house relative humidity is probably below 25 percent. Surveys in residences show that the relative humidity increases as would be expected in warmer weather. Fig. 3 represents the results of one such survey.[4]

When water vapor is allowed to enter a wall and condensation occurs on its outer cold elements, it appears as frost or liquid. If the weather temperature rises frequently, frost melts and becoming liquid, is likely to penetrate capillary materials like wood, or run down when the surface is non-absorbing or is already saturated with water. In weather that is continuously cold for a long period, the frost may build back into a cavity or fibrous insulation and, when it reaches a warmer plane, will run to lower, cooler levels where it forms a mass of ice. Water seepage to the weather side may occur harmlessly in masonry walls when the weather is above freezing but water seepage into the building must obviously be avoided. In typical frame construction with wood sheathing which has large water absorbing capacity, seepage is rare and occurs only after a long period of steady cold weather. More generally, moisture accumulates in wood sheathing and siding through the colder months and reaches a peak in late winter, after which the drying of spring and summer completes the annual cycle. The average winter temperature and its duration are factors in the condensation problem. In Fig. 4 the United States is divided into three