Early History of Attic Ventilation

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Abstract

Research literature and articles from professional magazines have been surveyed and reviewed with the aim of outlining the early history of attic ventilation between 1930-52. In addition, the question of the earliest use by the asphalt shingle industry of venting requirements has been addressed. The findings of this survey and review include the following:

Tyler S. Rogers introduced the "condensation control" paradigm to the architecture press in early 1938. The paradigm was based on work under way at the U.S. Forest Products Laboratory and on work recently funded by the National Mineral Wool Association under the direction of Frank Rowley at the University of Minnesota. The original 1938 Rogers article contained suggestions that the nascent insulation industry should be protected against claims of moisture damage. The two principal recommendations for moisture control under this paradigm were vapor barriers and attic ventilation. By 1952, when Rogers was in the employ of Owens-Corning Fiberglas, he more strongly stated that his effort at developing a condensation-control understanding was to defend the insulation industry.

The attic ventilation ratio “1/300” is an arbitrary number selected by the writers of FHA (1942) with no citations or references. One might speculate that it is based on Rowley’s 1939 research, which showed a slight performance difference between openings with vent ratios of 1/288 and 1/576. However, other evidence indicates it was not based on Rowley.

The asphalt shingle industry began to link installation practices to recommended and code-required venting practices in the mid-1980s.

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Aim and background

The aim of this paper is to describe and assess the early research and professional literature that underpins current attic ventilation practices. The period covered in this paper is 1930-52. In addition, the aim of the paper will be to determine when the argument that attic ventilation enhances shingle service life first appeared. It is not the aim of this paper to review actual attic ventilation practices nor is it the aim to provide professional guidance regarding attic ventilation. It is hoped this paper will be useful in the future review of attic ventilation requirements.

For purposes of this paper, an attic is the unoccupied space above a ceiling plane and beneath a steep roof system. It may include cavities in cathedral ceiling construction. Cavities in low-slope roof systems are outside the scope of this paper.

Vent devices on roofs first appeared as steeples, towers or cupolas, which assisted buoyant flow upward through a building. This was common in barns, mill buildings or any buildings subject to buildup of odors or contaminants. It was also common in buildings in hot climates to assist comfort by increasing air speed across the skin. Buildings designed for such flow are outside the scope of this paper. Nevertheless, flow upward from living areas or foundation areas in buildings into an attic cavity may play a predominant role in hygrothermal performance of attic systems (see Britton, below).

Most early roofing material, such as wood shingle, slate or tile, was applied to spaced wood lathing. Continuous roof sheathing began to appear in the late 1800s in some construction because it allowed the application of asphalt felt underlayment for additional protection against rainwater. In quality construction in northern climates, nails were sized so the points did not penetrate the underside of the sheathing. The use of longer nails that penetrated through the sheathing probably represented low-quality construction when it appeared in the first decades of the 20th century. During the depression of the 1930s, the use of asphalt shingle roofing materials on continuous 1-by-6 sheathing became the norm for one- and two-family construction. To what extent was ventilation practiced prior to the 1930s? It is difficult to provide an answer because reroofing often involves changes in reconfiguration of venting. Thus it may be necessary to state only that roof systems with and without ventilation were both used up to the 1930s.

Paul D. Close

Paul Close[1] was one of the early writers on preventing condensation on building surfaces in insulated assemblies. He wrote in *Transactions* of the American Society of Heating and Ventilating Engineers (ASHVE now ASHRAE). His comments were only indirectly about attic venting.

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[1] Close, Paul D. 1930. Preventing condensation on interior building surfaces. *ASHVE Transactions* no. 854, January 1930.

> Where should insulation be applied? From the theoretical standpoint, the most effective results are obtained by applying the insulation to the interior surface of the wall or roof, or as near in the wall or roof to the interior surface as possible, especially if the building is allowed to cool at night and is heated quickly in the morning.

He then gave five reasons for placing insulation inboard, all based on specific heat and lag-time considerations. But he followed by saying:

> There are other factors, or perhaps even greater importance than the foregoing, which make it advisable to apply the insulation as far as possible from the interior surface of the wall or roof. Probably the most important is that of providing the necessary vapor protection to the insulation, for no insulation will function satisfactorily if it is not properly vaporproofed.

Close makes no direct recommendations regarding attic ventilation, but his recommendation to ensure that insulation is applied tightly against the exterior roof deck, along with (bitumen) vapor protection was followed in the 1930s. Frank Lloyd Wright's Wingspread in Racine, Wis. exhibits exactly this construction with excellent results.[2]

Forest Products Laboratory

During the 1930s, the problem of paint peeling became widespread. It seemed to occur primarily on insulated buildings. The U.S. Forest Products Laboratory (FPL) was the first U.S. organization to write about the occurrence.

F.L. Browne[3] senior chemist with FPL cited two types of circumstances that have been observed to cause abnormal conditions of exposure leading to paint peeling. The first type was rainwater seeping through leaky joints left by poor carpenter work or faulty design. The second type was "moisture originating within the building and carried by air circulating within the hollow outside walls. When moisture laden air comes in contact with surfaces at sufficiently lower temperature, water condenses." He cited five conditions of this second type:

- Attempting to hasten the drying of wet plaster
- Designing parts of buildings in such a way that stagnant air spaces are enclosed by wood walls (i.e. porches or hollow columns)
- Lack of ventilation in unused attics
- Failure to secure a watertight basement

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[2] See Rose, W. 1997. Control of moisture in the modern building envelope: the history of the vapor barrier in the United States 1923-1952. *APT Bulletin*, Vol. XVIII. No. 4, October 1997.

[3] Browne, F.L.1933. Some causes of blistering and peeling of paint on house siding. US Forest Products Laboratory No. R6, Madison WI. 11 pp.

Activities within the building that humidify the air

Item 3 reads in full:

> Lack of ventilation in unused attics. During cold weather water may condense beneath the cold roof and drain down toward the cornice. If the top course of siding is placed below the frieze board the water is directed between siding and sheathing, coming directly in contact with the backs of the painted clapboards.

This is a rather explicit form of failure. In fact it is hard to imagine water running down toward the cornice along the underside of cold sheathing. Nevertheless, the observation of water behind siding at the top of the wall must have needed some explanation.

In 1937, Larry V. Teesdale, senior engineer with FPL, published "Condensation in walls and attics."[4] Regarding attics, he states:

> Roof condensation is reported far more frequently than sidewall condensation, not necessarily because it occurs more frequently but rather because it is more likely to be seen by the occupants. For example, in a pitched roof house having, say, fill insulation in the ceiling below the attic, condensation may develop during a severe cold spell on the underside of the roof boards, forming as ice or frost. When the weather moderates, or even under a bright sun, the ice melts and drips on the attic floor, leaks through and spots the ceiling below. Often such spots are assumed to be roof leaks and cause owners and contractors considerable unnecessary expense in attempting to waterproof a roof that is not leaking. If the attic has adequate ventilation little or no trouble will occur but adequate ventilation is sometimes difficult to attain, and tends to increase the heat loss.

On page 6, he explains that attics under pitched roofs can be ventilated either through windows or louvered openings or by separating roof boards 2 feet or more. The article contains no other mention of attic ventilation until the final page under General Recommendations: "For new construction it is recommended that a suitable vapor barrier be installed on the side wall studs and below the ceiling insulation and that some attic ventilation also be provided." The overall emphasis of the article is the importance of reducing indoor humidity.

Teesdale's recommendation for attic ventilation was quite clear, but the support for this position was his personal experience, which did not make it strongly into the research record.

[4] Teesdale, L.V., October 1937. Condensation in walls and attics. U.S. Department of Agriculture, Forest Service. Madison WI. 12 pp.

Tyler Stewart Rogers

Tyler Stewart Rogers was a writer on technical issues in the architecture press through the 1930s. By 1950, he was director of technical publications for Owens-Corning Fiberglas, but when his affiliation with OCF began is not known at this point.[5] He had become prominent as a contributor to "Timesaver Standards," a regular feature of *American Architect and Architecture* magazine. In November 1936, he published "Insulation: What we know and ought to know about it"[6] that promised that research was getting under way. The article concluded with: "It may confidently be expected that this new phase of building science will soon become as well established and as familiar as carpentry, masonry and steel work. Standardized practices are the objective."

He delivered on his promise in March 1938. "Timesaver Standards" had moved to *Architectural Record* magazine where the "standardized practices" were described, this time for "Preventing Condensation in Insulated Structures."[7] Rogers cited two sources: "Condensation in Walls and Attics" by L.V. Teesdale of the Forest Products Laboratory and "Condensation Within Walls" By Prof. F. B. Rowley and others. Rowley's work had been presented in January 1938, but had not as yet been published.

Rogers' article paints a picture that is surprisingly complete and up-to-date. That is, things have not changed much since their first appearance. The article begins: "Architects, owners and research technicians have observed, in recent years, a small but growing number of buildings in which dampness or frost has developed in walls, roofs or attic spaces. Most of these were insulated houses, a few were winter air-conditioned. The erroneous impression has spread that insulation 'draws' water into the walls and roofs...Obviously, insulation is not at fault." Note the hint that a new industry-insulation-needs to be defended against a perception that it leads to moisture problems. Teesdale, as well as Rogers, had sought to counter the notion that insulation "draws" water into constructions. It is worth noting that insulation does in fact "draw" water into walls and roofs in that it ensures colder temperatures for exterior materials during cold weather, leading to higher surrounding relative humidity and higher moisture contents for those materials. This can be confirmed using the ASHRAE dew-point method, which was about to make its appearance.

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[5] I was told that the Owens Corning Granville Ohio facility is planning to name a new building after Rogers. Nevertheless, employment records at Owens-Corning for Rogers are not available.

[6] Rogers, T.S. 1936. Insulation: What we know and ought to know about it *American Architect and Architecture* November 1936. New York.

[7] Rogers, T.S. "Preventing Condensation in Insulated Structures" *Architectural Record* March 1938, pp. 109-119.

He has a section titled “Explaining to Clients” in which he presents a comparison of liquid and vapor transport.[8] Note that he was selling this approach to clients, not to the construction industry; there is no corresponding section titled “Explaining to the Construction Industry.” Without going into the sociology of design and construction, it must be pointed out that Rogers, the architect, makes no effort to sell the theory to builders but rather leaves them with the responsibility of high-quality execution. “As with most other details of construction, workmanship has an important bearing on final performance. The most perfect barrier material, poorly installed, will fail to function at high efficiency.”

Rogers states later: “Absolute protection against occasional condensation in small amounts does not appear to be necessary. Wood with less than 23% moisture content is perfectly safe from dry rot and fungus growth.”

Toward the end of the article comes the section subtitled “Attic and Roof Insulation.”

> Principles that apply to wall construction apply with equal force to ceilings, attics and roofs, but somewhat different techniques are needed to meet the conditions encountered. A vapor barrier undoubtedly should be employed on the warm side of any insulation as the first step in minimizing condensation; venting to the cold air is an equally desirable second step. Either one may suffice; both are desirable.
>
> Venting of roof areas above insulation may be accomplished by various means, according to the construction involved. Unoccupied attics or loft spaces, above insulation installed at the ceiling below, should be vented by louvers in gable ends or side walls at the highest possible point, or by ridge ventilators or false chimneys. Wood shingle roofs applied on spaced shingle lath without vapor resistant papers provide sufficiently free vapor movement to make additional venting unnecessary, but roof decks of any kind which are covered with vapor-resistive materials should have special vents.

He shows three diagrams of venting. See Figure 1.

The following month, an article “Condensation” appeared without author attribution in *Architectural Forum* magazine.[9] It was similar to the *Architectural Record* article in most respects. It allows that wood may remain at 25 percent moisture content without fear of fungal damage.

> The single exception to (rare frost formation) has been the poorly ventilated attic. Such frost often takes a curious form known in some sections as “walnuts”; balls of rust-colored ice which gather on nail-ends projecting

[8] This image was repeated many times in the following decades. Unfortunately, it masks the role of temperature reduction in leading to high moisture contents of materials.
[9] Anon. 1938. Condensation. *Architectural Record.* April 1938. New York.

> through the roof boards which-since they are colder than the wooden parts of the roof-attract the water vapor. Such ice or frost seldom damages the roof structure, but if quickly melted by sun shining on the roof or a sudden rise in temperature may drip on the ceilings below and cause discoloration and even disintegration of the plaster.

This article concludes, “Condensation in attics is best prevented by providing adequate ventilation, supplemented where necessary by a vapor barrier on the underside of the attic joists.”

Frank B. Rowley

Professor Frank B. Rowley was well-known to the ASHVE (ASHRAE) community. He had established his reputation by measuring R-values of materials in the laboratory and by showing how these values could be used to accurately estimate heat loss through enclosures. His research had been funded by the National Mineral Wool Association. It was normal that the funding would continue for his studies on vapor transfer and condensation. In 1934, Rowley had been elected president of ASHVE. His prestige and valuable contributions to heat transfer may have contributed to relatively uncritical acceptance of his work on vapor transfer. He wrote on theory and on practice.

“A theory covering the transfer of vapor through materials”[10] laid out the theory of vapor diffusion. It begins:

> There has been much speculation about the theory relating to the transfer of vapor through materials and the application of the theory to building construction. For convenience it has often been assumed that the laws for vapor transmission are similar in form to those governing the flow of heat through the walls of a building, and that coefficients of vapor transmittance may be developed for materials or combinations of materials which may be applied in the same manner as coefficients of heat transmission...Before accepting a complete analogy between the two problems an analysis should be made to determine those elements which are similar and those which may be conflicting.

In short, Rowley finds the analogy convincing, and it thereby became the principal explanatory tool for moisture transfer. The question of whether this form of moisture movement is actually of significance in actual building performance was not asked until much later.

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[10] Rowley, F.B. 1938. A theory covering the transfer of vapor through materials. *ASHRAE Transactions.* No. 1134. July 1939. American Society of Heating Refrigerating and Air Conditioning Engineers, Atlanta GA.

In January 1939, Rowley, Algren and Lund published "Condensation of moisture and its relation to building construction and operation."[11] The study reported on five lines of investigation:

A further study of vapor barriers
Ventilation of walls through the exterior surfaces
The effect of vapor barriers on the drying of wet plaster
The effect of attic ventilation on the accumulation of moisture and frost within the attic and upon attic temperatures
The effect of vapor pressures on the rate of vapor travel through materials

They constructed three "doghouses" within a climate-controlled chamber at the University of Minnesota. The setup is shown in Figure 2. One had no intentional ventilation; one had "natural " ventilation (i.e., small holes in each of the two gables), and one had mechanical ventilation. The sheathing was removable to gain access to a small aluminum plate, which could be weighed for frost accumulation. The significant test for natural ventilation was conducted with an indoor temperature of 70 F, an indoor relative humidity of 40 percent and an outdoor temperature of -10 F. In test No. 19-1, the gable holes (presumably two such holes, one in each gable) were ¼ inch per square foot of ceiling area in size. In test No. 19-2,3, the gable holes measured 1/8 inch per ceiling square foot area in each gable. We might say, though Rowley did not use such expressions, that the vent ratio in 19-1 was 1/288 and the vent ratio in 19-2,3 was 1/576. There were no vapor barriers used in these assemblies.

Rowley found that there was no condensation in 19-1, but 19-2,3 showed a frost accumulation of 0.16 grams per square foot ceiling area per 24 hours. The case with no ventilation, under the same conditions, showed frost accumulation of about 3 grams/sf/24 hours. Based on this finding, Rowley's conclusions regarding attic ventilation are these:

> 4. It is possible to reduce the rate of condensation within a structure by ventilating to the outside. This method may be particularly effective in attics where the condensation occurs on the underside of the roof. Adequate ventilation may be obtained without serious loss of heat.
>
> 9. For cold attic spaces it is desirable to allow openings for outside air circulation through attic space as a precaution against condensation on the underside of the roof even though barriers are used in the ceiling below.

How legitimate are these conclusions?

Conclusion 4 seems to follow from Rowley's findings as he was able to demonstrate condensation on the aluminum plate in two cases and not in one other. But how significant is the rate of condensation that he did find? Assume the sheathing is ¾-inch pine. One

[11] F. Rowley, A. Algren, and C. Lund, 1939. "Condensation of moisture and its relation to building construction and operation" *ASHVE Transactions*, 45 No. 1115.

square foot of southern pine (density 36 pounds per cubic foot) weighs 2.3 pounds or about 1000 grams. Under dry conditions (10 percent moisture content), it contains 100 grams of moisture. Under wet conditions (23 percent moisture content, recall from Rogers), it contains 230 grams of water. The difference is 130 grams of moisture. Rowley showed that for an unvented attic to go from dry conditions to incipient wet conditions at -10 F, it would require 130/3 or 43 days. For an "undervented" attic of 1/576 vent ratio to go from dry to incipient wet conditions, at -10 F, it would require over two years (130/0.16 = 812 days). It is hard to conclude that the rate of accumulation Rowley found could, in any way, justify a need for attic ventilation for moisture control, and it certainly does not support the need for 1/288 rather than 1/576 venting.

Conclusion 9 does not follow from his findings. He did not study roofs with barriers in place. He provides no basis for concluding that allowing openings for outside air circulation is desirable.

FHA

The material presented above, from FPL, Rogers' article(s) in the architecture press and Rowley's ASHRAE research, together with vapor permeance measurements done at the National Bureau of Standards and Canadian Scientific Liaison Office, constitutes the entire work output from North America on the subject of moisture transfer in buildings prior to World War II. Prior to World War II, there were no "model" building codes, and the only regulatory documents were municipal building codes in larger cities and the Minimum Property Requirements of the Federal Housing Authority (FHA).

In January 1942, the *Property Standards and Minimum Construction Requirements for Dwellings* of FHA was significantly revised. Only one copy of this edition has been located- in the library at the U.S. Department of Housing and Urban Development in Washington DC. It is mimeographed, and contains the following section.

> 209 LIGHT AND VENTILATION
>
> K Attics (Includes air space between ceiling and flat roofs).
>
> Provide effective fixed ventilation in all spaces between roofs and top floor ceilings, by screened louvres or by other means acceptable to the Chief Architect.
>
> Net ventilation area for each separate space to be not less than 1/300 of horizontally projected roof area. Where possible, locate vents to provide effective cross-ventilation.
>
> Use corrosion-resistant screening over openings, mesh not less than 12 per inch.

This document is the source of the fabled "1/300" ratio. It appears here with no citation and no references. The vent ratio 1/300 is an arbitrary number. It has no significance in the physical performance of buildings. It may have been selected by FHA because it cuts between Rowley's 1/288 and 1/576. At the time of adoption of 1/300 by FHA, all that could be faithfully deduced from the research record is that, under the conditions of Rowley's tests, approximately three years of bitter cold temperatures would be necessary for attics with 1/576 venting ratio to reach significantly high levels of moisture in attic sheathing.

Incidentally, the page on which 1/300 first appears also contains the first mention of the need for ventilation in "basementless spaces." The following page contains the first mention of the need for vapor barriers with measured permeance.

Ralph R. Britton

Following World War II, the Housing and Home Finance Agency (HHFA), which directed FHA, undertook research to confirm (or not) the regulations put forward in January 1942. The principal investigator for HHFA was Ralph Britton. He contracted with Penn State University to conduct a series of tests on walls and roofs with the purpose of assessing the condensation performance of various wall and roof assemblies.[12] Britton's research has been described in detail in Rose (1995).[13] Britton may have had a hand in the initial formulation of the 1/300 vent ratio as indicated by his decision to use 1/300 as the vent ratio in his 1947 tests.

The first report began with a curious remark under "Test Procedure", "When this program started there was, to the best of our knowledge, no past experience to serve as a guide in setting up a test procedure." It is odd to imagine that Rowley's work had been ignored. If that is so, FHA's selection of 1/300 appears all that much more arbitrary.

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[12] Britton, Ralph R. July 1948. "Condensation in Walls and Roofs", Housing and Home Finance Agency Technical Papers #1, 2, 3.
Britton, Ralph R. April 1948. "Condensation in Walls and Roofs", Housing and Home Finance Agency Technical Paper #8.
Britton, Ralph R. June 1949. "Condensation in Wood Frame Walls Under Variable State Conditions of Exposure", Housing and Home Finance Agency Technical Paper #12.
Britton, Ralph R., January 1949, "Crawl Spaces: Their effect on dwellings - an analysis of causes and results - suggested good practice requirements", Housing and Home Finance Agency Technical Bulletin No. 2, January 1948. Reprinted in Housing and Home Finance Agency Technical Bulletin No. 8.
[13] Rose, W.B. 1995. The history of attic ventilation regulation and research. *Thermal Performance of the Exterior Envelopes of Buildings VI* Conference and Proceedings. American Society of Heating Refrigerating and Air Conditioning Engineers (ASHRAE), Atlanta GA.

The test panels were flat-roof structures within a climatometer at Penn State. The test findings related to rockwool-insulated roof panels can be summarized as in Table 1.

Table 1

case	Vapor barrier	insulation	ventilation	First finding	Second finding	conclusion
1	Vb, continuous	Rock wool	1/300	Ok	Ok	Ok
2	Vb, facing material	Rock wool	1/300	Ok	Ok	Ok
3	No vb	Rock wool	1/300	Frost	Frost	Visual[1]
1a	As in 1	As in 1	None	Some frost	Ok	Ok
2a	As in 2	Facing unstapled	1/300	Ok	Ok	Psych[2]
3a	As in 3	As in 3	1/100	ok	Slight moist.	Psych[2]

[1]"Visual" means there was visual evidence of frost

[2]"Psych" means that though there was no visual evidence of condensation, the psychrometric conditions indicated that condensation was imminent.

These findings indicate expected outcomes with tests 1, 2 and 3. However, 1a showed the unexpected outcome of good performance with a vapor barrier but without ventilation. And 3a showed that ventilation in excess of 1/300 could lead to degraded performance. Britton drew no final conclusions from these findings-his third report begins “research has been stopped for lack of funds.” However, among his interim conclusions, were that roof sections 2a and 3a are questionable for suitability.

Britton also wrote an extended report (the first of its kind) on crawl spaces. He made several significant findings in this report, including the finding that air from wet crawl spaces moves upward along furring chases and plumbing chases up into the attic, bypassing the living space.

> Note: Where an effective vapor barrier is assured in the top-story ceiling, loft or attic space ventilation specified above may be greatly decreased. Such decrease may well be as much as 90% where controlled construction is assured and walls or crawl space do not contribute to moisture supply in the attic or loft space.

This conclusion is important because it highlights the importance attached by Britton and HHFA to moisture loads from a foundation. It leads to speculation that if Britton’s thinking had been pursued, a primary means of regulated moisture control for attics might have been air-tightening at the ceiling plane, and 1/300 venting could have been reduced to 1/3000.

Britton wrapped the conclusions from his wall-roof studies and his crawl space investigations into an important article, "Condensation Control in Dwelling Construction: Good Practice Recommendations".[14] This article became the August 1949 HHFA bulletin, "Condensation Control in Dwelling Construction".[15] This publication was widely distributed and used for much post-war housing. A diagram from this brochure is shown in Figure 3.

Acceptance

The Building Officials Conference of America (BOCA) model building code began in 1948. It took up the 1/300 vent ratio on its own terms as follows:

> SEC. 115.3 ATTIC SPACES All attic spaces and unoccupied spaces between roofs and top floor ceilings shall be ventilated by not less than (2) opposite louvres or vents with a total clear area of opening not less than one-third (1/3) of one (1) per cent of the horizontally projected roof area.[16]

The fourth edition of Ramsey and Sleeper's *Architectural Graphic Standards*[17] used information and tables directly from HHFA "Condensation Control in Modern Buildings." Their drawings came from T.S. Rogers' March 1938 *Architectural Record* article.

In 1952, the Building Research Advisory Board of the National Research Council (National Academy of Science) held a conference on *Condensation Control in Buildings as Related to Paints, Papers and Insulating Materials*. The conference planner was T.S. Rogers, who was by this time the director of technical publications for Owens-Corning Fiberglas. His opening remarks began:

> …with new materials and techniques and designs we have new things to blame for the faults in our buildings. It is never in fashion to blame ourselves, of course; it is always some other Joe who caused the trouble. So paint failures were at first blamed on insulation and condensation; and condensation was itself blamed on insulation, until the insulation industry, in self defense, had to undertake research to establish its innocence.

Here Rogers repeats in even stronger language than in 1938 that this effort at awareness and control of condensation has at its heart the commercial interests of the insulation industry. He continued:

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[14] Britton, R. R. "Condensation Control in Dwelling Construction" *HHFA Technical Bulletin #10*, May-June 1949. Housing and Home Finance Agency.
[15] Housing and Home Finance Agency (HHFA) "Condensation Control in Modern Buildings" Washington DC August 1949.
[16] BOCA 1948. Abridged Building Code. Building Officials Conference of America, Inc. Adopted September 16, 1948. Available from US-HUD Library.
[17] Ramsey, C.G and H.R. Sleeper. 1951. *Architectural Graphic Standards*. Fourth Edition. Wiley. New York.

> While this research and similar work by the paint industry was going on, there was a great deal of buck-passing. The insulation men blamed the paints or the wet lumber and some painters retaliated by refusing to paint an insulated house. Then the building paper manufacturers got caught in the middle; their new sheathing papers were blamed for causing condensation instead of shielding a building from dampness. The foils were soon in the ring with the papers, while architects, builders, building owners and the general public watched this battle royal and wondered if any of the fighters was worth betting on.

Attic ventilation was part of the discussion though there were no representatives of roofing companies among the 130 attendees. Paul Cadwallader, a lumber dealer from Pennington, N.J., described his experience:

> What do you do if another householder calls up and says, “My new house looks like the very devil. The shingles are all standing up. It looks like a chicken with its back to the wind. There must be something wrong with the material. You sold it to me. What are you going to do about it?” I can’t quote her some magic formula for moisture infiltration and say “It just could not happen,” because it did happen. It’s there.

L.V. Teesdale noted (p. 74), “In spite of louvered openings for ventilation, condensation is frequently found in attic spaces.” Frank Rowley responded to Teesdale’s presentation with:

> Another point brought up by Mr. Teesdale is this question of attic ventilation. I think most people have had some experience with attic ventilation in trying to get good distribution of air around the attic. Certainly to provide enough openings is one of the most difficult things. You can put a number of openings in a building, but it is very difficult to get the openings distributed around the edge of the attic in such a way that you will get good distribution of the ventilation. If you do not, you are liable to have one space in the attic that will cause more damage than if you had no attic ventilation. Too much ventilation may even cause damage by cooling off the top of the insulation. We have taken cases where excess ventilation will cool the top surface of the insulating material…So too much ventilation may be dangerous just as well as too little.

Tyler S. Rogers closed the conference with:

> My final recommendation is, let’s dare to stick out our collective necks and put down our best opinions, based upon technical background, as the thing to do. State it simply: This is what we believe you should do now. And then have the courage to go out a year hence, or six months hence if we need to, and say, “I have learned a little better, so now do it this way.”

In summary, the conference provided the commercial context in which the overall condensation-control effort should be seen. It gave the view that attic ventilation is not a straightforward means of addressing condensation in attics. And it closed with encouragement to continually revise building strategy for good performance.

Effects on roofing materials

If attic ventilation became a recommended practice in 1938 and a code-required practice in 1948, when did the argument first appear that attic ventilation enhances shingle service life? Early surveys by the National Bureau of Standards[18] did not include discussion of ventilation but showed buildings with and without vent devices.

In 1974, one of the first ridge vent device manufacturers, HC Products, produced "Fundamentals of Residential Attic Ventilation."[19] The authors, Herb Hinrichs and Clarke Wolfert, cited reduction in summertime heat and wintertime water vapor as the two rationales for attic ventilation. Shingle service life was not mentioned. By 1984, the HC devices were produced by AirVent Inc., and material from the "Fundamentals" brochure was incorporated into "Principles of Attic Ventilation" by AirVent, Inc.[20] The preface contains, "Also, the remodeling industry is increasingly aware of the importance of proper ventilation to assure roof shingle durability and performance."

The Asphalt Roofing Manufacturers Association is responsible for the *Residential Asphalt Roofing Manual*. It was first published in 1984. The 1988 edition contains the following on page 20:

> Proper ventilation of the attic areas is a little understood but very helpful method of not only controlling heating and cooling costs, but also getting maximum service life out of the building materials used in the roof assembly. Possible problems include:
> - Premature failure of the roofing including blistering
> - Buckling of the roofing due to deck movement
> - Rotting of wood members
> - Moisture accumulation in insulation

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[18] Snokes, H.R. and L.J Waldron. 1941. Survey of roofing materials in the North Central states. Building Materials and Structures Report BM875. National Bureau of Standards, Washington DC.
Snokes, H.R. and L.J Waldron. 1942. Survey of roofing materials in the South Central states. Building Materials and Structures Report BM884. National Bureau of Standards, Washington DC.
[19] HC Products, Inc. 1974. Fundamentals of residential attic ventilation. Princeville IL. 29 pp.
[20] AirVent, Inc. 1984. Principles of attic ventilation (Third edition). AirVent, Inc. Peoria Heights IL. 31 pp.

> During the summer months, radiant heat from the sun can cause very high roof deck temperatures. Gradually, the entire attic space is heated, and in turn, the entire dwelling feels the effect of a hot roof. This heat build-up can be short-circuited by ventilating the underside of the roof deck. Recent research has reinforced the idea that prolonged exposure to high heat levels will accelerate aging and shorten the service life of asphalt roofing products. Having a properly ventilated flow through air space between the roof deck and any layer of insulation present will offer protection against heat build-up.

The earliest dates for shingle warranties being linked to attic ventilation requirements could not be determined in the preparation of this paper. However, archival material at NRCA indicates that the links first may have first begun to appear in the late 1980s and early 1990s.

Conclusions

The principal early sources of attic ventilation requirements have been presented. The background presented here is, in the opinion of the author, a complete and exhaustive list of the significant sources of the current regulations and practice.

Tyler S. Rogers introduced the “condensation control” paradigm in the architecture press in early 1938. The paradigm was based on work under way at the U.S. Forest Products Laboratory and on work recently funded by the National Mineral Wool Association under the direction of Frank Rowley at the University of Minnesota. The original 1938 Rogers article contained suggestion that the nascent insulation industry should be protected against claims of moisture damage. The two principal recommendations for moisture control under this paradigm were vapor barriers and attic ventilation. By 1952, when Rogers was in the employ of Owens-Corning Fiberglas, he more strongly stated that his effort at developing a condensation-control understanding was to defend the insulation industry.

The attic ventilation ratio “1/300” is an arbitrary number selected by the writers of FHA (1942) with no citations or references. One might speculate that it is based on Rowley’s 1939 research, which showed a slight performance difference between openings with vent ratios of 1/288 and 1/576. However, other evidence indicates it was not based on Rowley.

The asphalt shingle industry began to link installation practices to recommended and code-required venting practices in the mid-1980s.

Professionals in the building industry—design, codes and construction—may view the support for the current regulations, described in this paper, as being strong or weak. In the opinion of the author the support is weak, and a strict interpretation of 1/300 compliance is not appropriate. Indeed, the building industry may wish to question whether ensuring moisture control is an appropriate duty and responsibility of the building codes, and, if it is, whether prescriptive venting regulations are the best way to provide it. Perhaps the building codes may wish to study removing some of the overly-exact provisions of the code, and instead rely on the industry to provide vapor control, as it relies on the roofing industry to provide weather protection against rain.

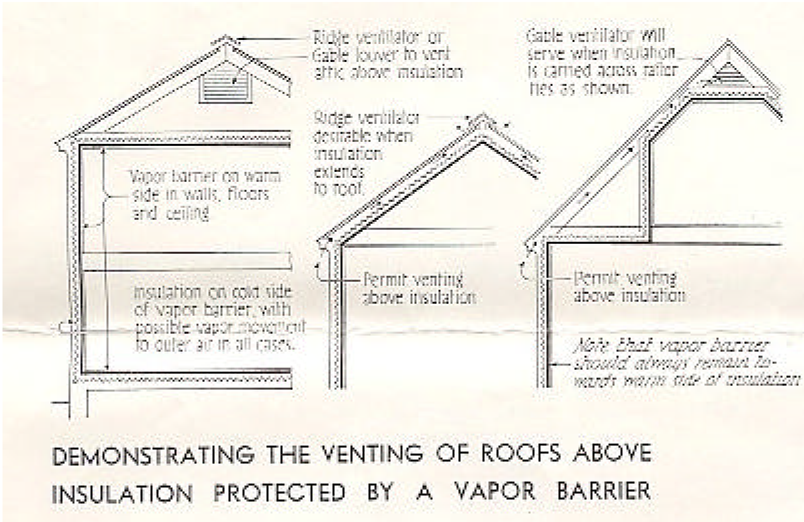

Figure 1. Illustration of three roof venting strategies from Rogers “Preventing Condensation in Insulated Structures” Architectural Record, March 1938. These drawings reappeared in Architectural Graphic Standards, fourth edition, 1951.

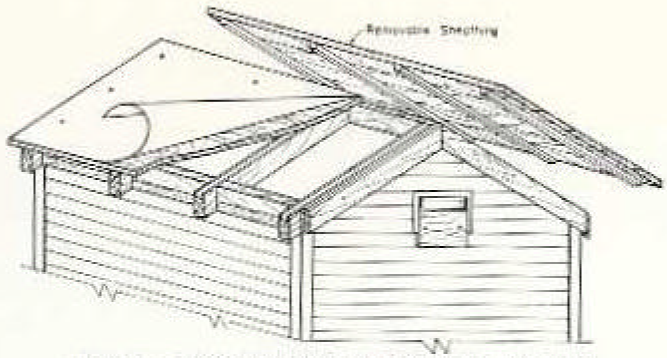

FIGURE [illegible]. CONSTRUCTION DETAILS OF ATTIC FOR ATTIC VENTILATION TESTS

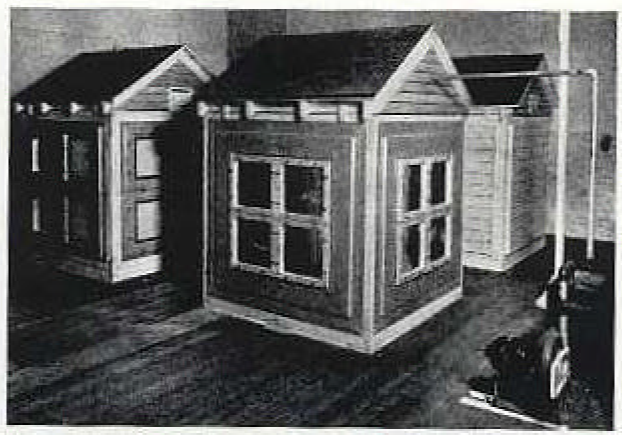

FIGURE 21. VIEW OF SET-UP FOR VENTILATED AND UNVENTILATED ATTICS

Figure 2. Drawing and photo showing the setup of Frank Rowley's University of Minnesota attic research.

HIP ROOF, ENCLOSED RAFTERS

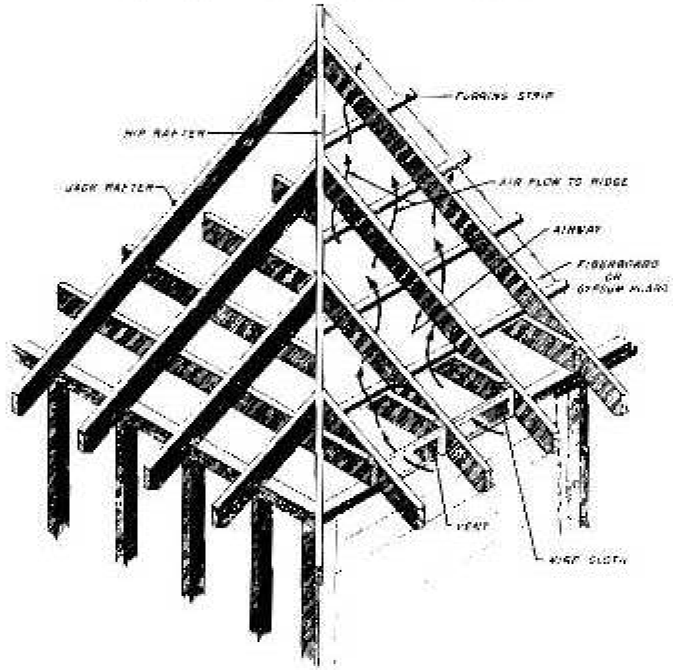

FIGURE 45. *Hip roof, enclosed rafters.* Hip-roof construction presents a special problem when it is desired to enclose or insulate the roof because of the complete closure of the spaces between the jack rafters by the hip rafter when the insulation is applied between or on the under side of the rafters. If rooms are built into the attic they should be constructed independent of the roof structure or furred in such a way that air will not be trapped in the construction. Fiberboard is used for thermal insulation and the interior surface in this detail. An inlet for fresh air is shown below the eaves and airways throughout the roof construction. Although not shown, it is assumed that an outlet will be provided to permit the discharge of air near the ridge. Figures 41, and 46 to 49 indicate how this may be done and the sizes of openings are given in "Good practice recommendations."

Figure 3. Diagram of hip roof venting from HHFA brochure "Condensation Control in Dwelling Construction" 1949.