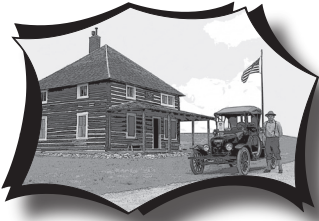




Early 20th-Century Building Materials: Fiberboard and Plywood

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This tech tip is the second in a series about innovative building materials developed in the first half of the 20th century and commonly incorporated into Forest Service buildings. The series will help you identify materials by describing their histories, manufacture, and physical characteristics. This series also addresses common problems and provides guidance on maintenance, repair, and replacement.

Highlights...

- Fiberboard and plywood (figure 1) have been used in Forest Service facilities since early in the 20th century.
- Moisture is the most common cause of damage to fiberboard and to plywood made with glues intended for interior use.
- Often, damaged fiberboard and plywood can be repaired using several techniques described in this tech tip.



Figure 1—Varnished plywood covers the walls and ceiling of the Rabideau infirmary, which was built in 1935.

As noted in the tech tip, *Early 20th-Century Building Materials: Introduction* (<http://www.fs.fed.us/t-d/pubs/htmlpubs/htm06732314/> Username: t-d Password: t-d), the Forest Service always has encouraged the use of wood-based products in its facilities. As early as 1933, acceptable wall and ceiling products included fiberboard (sometimes



referred to as rigid board, building board, or wallboard) and plywood. The Washington Office's *Improvement Handbook* (1937) and *Principles of Architectural Planning for Forest Service Administrative Improvements* (1938) noted that certain fiberboards were acceptable for use as insulation and on interior walls and ceilings. These included Masonite, Nu-Wood, Du-X, and Fir-tex. To support the Forest Service's goal of using wood, fiberboards were favored as a finish material, although they were also deemed suitable as a lath or base for plaster finishes.

Although the first American patent for fiberboard was issued in 1858, fiberboard was not used widely until the 1910s. During World War II, production increased because fiberboard could be installed easily and quickly in temporary military structures. The fiberboard industry also grew with the demand for housing after the war, particularly as an interior finish. Some fiberboard materials were manufactured for exterior application, but they often performed poorly.

Plywood, another wood-based product, gained favor because of technological advances during World Wars I and II. It could be used for interior or exterior applications depending on the type of adhesives used in the plywood. By the 1950s and 1960s, plywood and its cousin, particleboard, were preferred over fiberboard for many applications.

Fiberboard

Fiberboard is a generic name for construction panels made of wood or vegetable fibers. Some are homogenous materials, while others are laminated sheets with fiber cores and surfaces of ground wood. The earliest fiberboard panels were made with fibers from an array of materials including jute, straw, sugar cane stalks, flax, hemp, grass, newspaper, and peanut shells. They were manufactured under names such as Fir-tex, Homasote, Masonite, Beaver Board, Feltex, Nu-Wood, and Upson Board.

Wood has always been the most common fiber used in fiberboard. Historic manufacturing processes varied, but most required a pulping process that cooked or ground the wood to separate its fibers. The pulp was mixed with binders such as glue, asphalt, or resins and moved onto screens where heavy pressure and heat squeezed out water and compressed the fibers. This process bound the wood fibers to each other

and the binders, producing one smooth side and one side that was textured because it had been pressed against the screen. The formed sheets were dried, trimmed, and, in some cases, finished with paint, enamel, paper, fabric, or glaze. Eventually, processes were developed to cover the panels with wood veneer or plastic laminate.

Because moisture was their primary enemy, fiberboards often were treated with waterproofing materials to retard rot and swelling. Asbestos, plaster of Paris, clay, turpentine, paraffin wax, or other materials were added to some mixes to improve fire resistance and produce other desirable qualities such as stiffness, hardness, smooth surfaces, increased strength, or durability.

Fiberboard products were valued for ease of use, particularly by unskilled workers. For the Forest Service, this was particularly important when young, untrained men from the Civilian Conservation Corps constructed facilities. Unlike plaster walls and ceilings, fiberboard could be applied quickly and required no drying time. The *Improvement Handbook* (1937) indicated that, for reasons of economy, fiberboard was recommended as a finish in attics, basements, and closets even when other spaces were plastered.

The joints between fiberboard panels could be treated in several ways. The *Principles of Architectural Planning for Forest Service Administrative Improvements* (1938) promoted a V-groove joint (figure 2), rather than the more common practice of covering joints with battens. The Northern Region *Construction and Maintenance Handbook* (1935) recommended that Masonite or plywood be installed horizontally on walls, with a chair rail applied over the horizontal seam between sheets. If these wallboards were installed in dwellings, the handbook recommended varnishing them. In other buildings, Masonite panels were to be finished with light-colored calcimine. Calcimine is a low-cost, water-based paint (sometimes known as distemper) containing glue and coloring.

Fiberboard is differentiated by density. Most historic fiberboard can be categorized as low-density (insulation) board, medium-density board, or hardboard.

Low-Density Fiberboard

Low-density fiberboard was known as insulation board because of its sound-deadening and thermal qualities. This

33. Plywood, Masonite, Nu-wood, etc.:

- a. Fabricated or processed wood products frequently offer a good, cheap solution of the problem of interior wall and ceiling finish. Random width, "V"-jointed fabricated boards, having a range of colors and including stock cornice and panel moulds, are available.
- b. The ease and speed of erection, coverage, etc., offered by these materials, afford a very much lower labor cost than the use of plaster. For offices they prove very serviceable; often avoiding delays in construction, etc., caused by waiting for plaster to dry thoroughly before erecting wood trim, etc.



- c. For appearance, "V"-jointed intersections are to be preferred to the stock 3/8" x 2 1/2" cover moulds.

Figure 2—This section of page 24 of the Forest Service's *Principles of Architectural Planning for Forest Service Administrative Improvements* (1938) explains acceptable uses of plywood, Masonite, Nu-Wood, and similar materials.

lightweight, rigid product made of fibrous pulp was available in sheets, planks, and tiles. Insulation board was best suited for interior applications because of its susceptibility to water damage.

Insulation board could be installed on interior walls and ceilings and painted or calcimined. Left unfinished, its brown face could be easily scored or cut to create interesting patterns (figure 3), and then painted to provide an easily cleaned surface (figure 4). Sheets with beveled edges were available and offered additional decorative properties. Sometimes insulation board, rather than traditional wood lath, was used to support plaster.

While the thickness of insulation board ranged from 3/8 to 1 inch, Forest Service guidebooks often recommended 1/2-inch insulation board for facilities. Sheets were 4 to 8 feet wide and could be up to 16 feet long. Panels used as insulating lath under plaster typically measured 18 to 24 inches wide and 48 inches long. Insulation board was secured to the building frame with adhesives, nails, screws, or

patented methods such as dropped metal grids for ceilings, the forerunner of the suspended ceilings found in many offices today.

Early trade names for insulation board included Insulate, Fir-tex, and Nu-Wood—all of which were made from wood pulp. In 1921, a fiberboard was produced using bagasse, the dry pulp byproduct of sugar cane after the juice has been extracted. This fiberboard was the first of many products developed by Celotex Co., which later produced acoustic materials such as the perforated Acousti-Celotex Cane Tile.

The first Masonite product, made in 1927, was a 7/16-inch insulation board that could be used as structural sheathing, sound insulation, and an interior wall surface. Plaster containing no more than 10 percent lime could be applied directly to the board. Other early Masonite products included beveled tiles and planks and the Litecol board, which was nearly white.

Masonite Corp. used a unique pulping process. Instead of cooking or grinding the wood chips, a machine ex-



Figure 3—This fiberboard ceiling in the Butte Falls Ranger Station (Rogue River-Siskiyou National Forest, Pacific Northwest Region) has been carved into a decorative pattern. The ceiling is the natural brown color of the wood pulp from which it was manufactured.

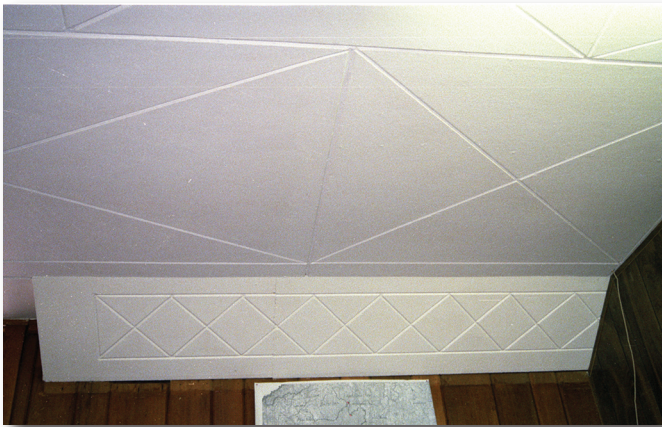


Figure 4—The fiberboard ceiling in the Fenn Ranger Station office (Moose Creek Ranger District, Nez Perce National Forest, Northern Region) has been carved and painted.

ploded them with such force that the wood fibers separated. Masonite Corp. later concentrated on producing its popular hardboard (see the *Hardboard* section).

Medium-Density Fiberboard

Homasote, Beaver Board, and Upson Board were medium-density fiberboards promoted for use in a variety of applications. Homasote, introduced in 1916, was a homogenous material made of recycled newspapers (the source of its gray color) and petroleum wax. Touted as an insulation and structural board for interior and exterior

use, it was available as smooth, striated, or wood-textured panels and as beveled siding. Panels as large as 8 by 14 feet eliminated the need for battens or seams in most rooms. Homasote is still manufactured today.

Beaver Board was a laminated sheet product invented in 1903 and perfected with several patents in the 1910s. The 1914 patent described a $\frac{3}{16}$ -inch-thick board with an interior layer of ground wood covered by thin layers of cooked wood on each side to provide moisture resistance and strength. One side was finished with a thin layer of textured ground wood for decorative purposes. Used through the 1920s, this version of Beaver Board came in 32- and 48-inch widths. The back was stamped with the company's logo and instructions, while the front had a pebbled finish that could be painted, stained, or left natural. To allow for expansion, panels had to be installed $\frac{1}{8}$ inch apart. Decorative battens typically covered the gap.

Upson Board was another laminated fiberboard with one textured side, similar in appearance to Beaver Board. The primary difference was that the back of Upson Board was not stamped with the brand name. Instead, its center layer was dyed blue, making it readily identifiable. Three widths (32, 48, and 64 inches) and seven lengths were available. In 1920, the manufacturer patented the Upson Self-Clinching Fastener, a five-pronged steel fastener. These were nailed to studs and the fiberboard panels were pressed onto the prongs, which held them in place.

For several decades, medium-density fiberboards remained popular even as their manufacturing processes and ingredients changed. In 1928, CertainTeed Corp. bought Beaver Board Co. and continued to produce Beaver Board under that trade name until the early 1940s. Upson Co. used the name briefly after buying the Beaver Board factory from CertainTeed in 1955. They continued to make Upson Board, Beaver Universal Fiberboard, and Beaver Fiberboard. The original Upson Co. closed in 1984.

Hardboard

Most historic hardboard was $\frac{1}{8}$ to $\frac{5}{16}$ inch thick, although two boards could be glued together to make a panel that was more rigid. Masonite Corp. introduced its first hardboard in the early 1930s. The Presdwood hardboard, from $\frac{1}{10}$ to $\frac{5}{16}$ inch thick, was used for interior finishes and

as battens over other Masonite products. Panels could be nailed or glued vertically or horizontally, then painted or wallpapered. A more durable product known as Tempered Presdwood was introduced in 1931. Often, it was screwed to studs and its joints covered with decorative battens. Temptrtile, a popular choice for bathrooms and kitchens, was a Masonite water-resistant hardboard embossed to look like 4- by 4-inch tiles (figure 5).

Masonite and other hardboards became staples of premanufactured housing and lined the interiors of more than 150,000 Quonset huts during World War II (figure 6). By the 1950s, hardboard siding was available in panel, shi lap, shingle, and board-and-batten styles. Optional features included factory-applied primers, vented mounting strips, and several textures. Another 1950s Masonite product was a gray, wood-grained interior wall panel known as Misty Walnut. Masonite's Royalcote, with its polished and durable faux wood finish, also proved popular.



Figure 5—Temptrtile, a hardboard product embossed to resemble tile, was used as a water-resistant wainscot in the cook's bathroom at the Fenn Ranger Station.



Figure 6—Masonite was often used to finish the interiors of the Quonset huts that the Forest Service acquired from the military after World War II. This Quonset hut is now used for storage at the Duck Creek Administrative Site (Juneau Ranger District, Tongass National Forest, Alaska Region).

Identification of Fiberboard Panels

Fiberboard usually can be identified by its brown or gray color and homogenous appearance. If fiberboard is painted, look for clues such as joint moldings, beveled joints, or scoring. Check areas such as basement stairs and attics where unpainted surfaces may be exposed. You may be able to see cross sections where the fiberboard has been broken off or cut for electrical boxes, plumbing lines, or mechanical equipment.

When tapped, insulation board will sound somewhat hollow and softer than gypsum board or plaster, although numerous layers of paint may minimize this difference. If you can't tell whether a surface is fiberboard using the methods described above, choose a concealed area (a closet or under the eaves, for example) and drill a small hole, preferably with a hand drill. This will help you determine the thickness of the board and will provide drill shavings that can be examined for color, texture, and material.

Maintenance and Repair of Fiberboard

Fiberboards share several problems, but susceptibility to moisture damage is the most common. Insulation board is more susceptible to moisture damage than denser fiberboard, although all fiberboard products can warp or rot in humid

areas or when water has penetrated them. Keep fiberboards dry. Clean them with a damp cloth and dry excess moisture with a clean cloth. Don't use soap or harsh detergents unless the surface is covered with paint or another protective finish.

Because insulation boards are relatively soft, they can be dented or punctured easily. Hardboard is brittle. In any case, unprotected edges and corners of fiberboard products are especially vulnerable. Consider installing plastic corner guards, door bumpers, and other protective devices. Arrange furniture and place fixtures in a way that will minimize contact with fiberboard walls.

If laminated layers of wallboard are separating, they can be reattached by applying or injecting wheat paste, an adhesive commonly used in conservation work because the changes can be undone relatively easily. You can make your own paste with wheat starch from a natural foods store (see recipe below), although it may be easier to buy wheat paste from an art or archival products supplier. If the wallboard's fibers are separating:

- Thin wheat paste with water.
- Use the thinned paste to soak the area.

This approach is feasible for small areas. Extensive damage may require replacing the wallboard panel.



Wheat Paste

Recipe

Mix 1 tablespoon of wheat starch with 5 tablespoons of distilled water

Microwave on "High" for 20 to 30 seconds, then stir.

Repeat several times until the paste is stiff and translucent.

Let the paste cool before using.

All fiberboards expand and contract with humidity and should be installed with gaps between the panels. Gaps that are too small can cause the board to warp or the finish to fail. If the fiberboards were installed with too small a gap, trim the fiberboards carefully to provide enough space for expansion.

If you can remove a warped fiberboard panel without damage, wet it slightly, apply pressure to flatten it, and allow it to dry before reinstalling it. Use small, inconspicuous nails or screws when reattaching sagging fiberboard on ceilings.

If the fiberboard is too damaged to repair, replace it. Fiberboards are still made today. Some modern products match the size and appearance of some historic products. Another option is to reuse fiberboard from a less visible area (such as a closet or attic) or from buildings that are not historically significant. Substitute materials, such as gypsum board, may be acceptable replacements for painted wallboard. Be sure to consult with your heritage staff and State Historic Preservation Office before removing or replacing any materials.

Plywood

Most people are familiar with plywood, a laminated product consisting of thin layers of wood glued together with alternating perpendicular grain orientations. Until about 1919, plywood also was known as scale board, pasted wood, and built-up wood. Plywood is lighter and stronger than solid wood, is more flexible, and has a high shear value.

In the nineteenth century, plywood was made of thin strips of saw-cut wood and was typically used for furniture and door panels. The plywood industry began to flourish after rotary cutters were invented in the 1890s. These machines cut large, thin sheets of wood by rotating a log against a knife. This advance permitted the development of larger and stronger sheets of plywood.

Despite considerable attention, plywood production was rather lackluster in the early 1900s. This changed during World War I when the product was improved and used to construct lightweight aircraft. With these advances, public perception shifted. Plywood, no longer seen as a cheap substitute, became valued in a variety of building applications.

The Forest Service's Forest Products Laboratory is credited with significant contributions to plywood technology. The lab began testing plywood sheathing in the late 1920s and successfully erected an experimental stressed-skin plywood house in 1935. Two years later, the Forest Products Laboratory built the first prefabricated low-cost plywood house.

A series of other firsts emerged for the laminated sheet material in the 1930s. These included the introduction of the first water-resistant plywood for exterior use (1934), the first commercially prefabricated house with exterior plywood (1936), and the design of the plywood Dri-Bilt house (1938) that featured PlyScord subfloors and sheathing, PlyWall ceilings and walls, PlyPanel built-ins, and PlyShield siding in over a million low-cost homes. Plywood had become an accepted building material.

The first standard-size sheets of plywood were 3 by 6 feet, but by the early 1930s, 4- by 8-foot sheets were standard. They typically had an odd number of layers, although plywood with even numbers of layers has been produced since World War II. As the techniques for manufacturing plywood were perfected, manufacturers increasingly offered plywood with decorative veneers and finishes. Some were made with striations or V-shaped grooves carved into them. Others were embossed or prefinished in several colors.



Figure 7—The interior of the infirmary at the Rabideau CCC camp (recently designated as a National Historic Landmark) is finished in varnished plywood, including curved vaults in the hallway and some rooms. Camp Rabideau is part of the Blackduck Ranger District (Chippewa National Forest, Eastern Region).



Figure 8—These plywood cabinets, constructed by the CCC in the cookhouse at the Fenn Ranger Station, are on the kitchen side of the serving counter. In this structure, cabinets visible only to the cook are plywood, while cabinets visible from the dining room are constructed of solid lumber.

Originally limited to door panels, walls, and ceilings (figure 7), plywood eventually was accepted in other applications, such as sheathing and cabinetry (figure 8), and exterior finished surfaces.

Identification

The most obvious characteristics of plywood include its wood grain, laminated layers, and the football-shaped plugs used as patches when defects are removed from a layer. Often, these plugs are visible even after the plywood has been painted.

Plywood has been available with interior-, exterior-, or marine-grade glues since the late 1930s. Interior glues remain the cheapest, but marine glues provide the most resistance to delamination (separation of layers) if the plywood gets wet. Normally, plywood is stamped with its strength and service ratings.

Maintenance and Repair

Plywood is as durable as solid wood if the right type has been selected and it is properly maintained. Interior plywood can be maintained much like fiberboard. Dust regularly or clean with a damp cloth. Exterior plywood requires preventive maintenance to protect it against rot, delamination, warping, and weathering. Minimize the potential for damage by keeping gutters and drainpipes

clean, making sure the ground is at least 8 inches below plywood siding, and removing adjacent debris and vegetation that hold moisture. Make sure the exterior finish—whether it is paint, stain, or other material—is kept in a sound condition through regular maintenance and reapplication. Weathered plywood can be sanded lightly and sealed.

Most material failures result from using plywood made with interior glues in exterior applications. The glues fail and the layers come apart. If the layers have begun pulling apart, but the panel is generally sound, the layers can be reglued by using a large syringe (found at veterinary supply stores) to inject wood adhesive between them. Alternatively, a utility knife can be used to cut a slit in the top layer and raise it just enough to daub adhesive between it and the next layer. Either clamp the layers (if the panel is vertical) or place a sandbag or other heavy object on the surface (if the panel is horizontal) until the adhesive dries. If the delamination is extensive, the panel may need to be replaced.

Plywood installed without any space between adjoining panels may buckle when it expands. Thin sheets that have buckled can sometimes be straightened by using a rotary saw to carefully trim off a narrow sliver at the joint. More fasteners may need to be added. Thicker panels probably will need to be replaced.

Plywood that has minor damage from impacts usually can be repaired using wood putty. Be sure to use putty designed for the application. Exterior putty and paintable putties are available. Some putties will take stain, but test the putty before using it to make sure the cured and stained patch will match the surrounding surface. If the impact damage is extensive or if it affects the strength of the panel, replacement is the best option.

You can treat rotten plywood by removing unsound areas and replacing them with matching plywood. Apply wood preservative, paint, or other protective sealant as appropriate afterward.

Plywood is readily available, so replacing panels with matching materials may be easy if the surface is smooth and covered with paint. It may be more difficult to match special finishes such as embossing, striations, and grooves. If the plywood has a clear finish, it is important to match the species, grain, and other visual characteristics of the original plywood. It's also important to match the type of clear finish because different finishes age differently. For instance,

varnish yellows as it ages, water-based polyurethane remains clear, and oil finishes darken.

Today, plywood sheathing is being supplanted by oriented strand board (OSB), its cheaper cousin that was developed in the late 1970s. OSB is not a good substitute for exposed plywood surfaces in historic buildings because it has a distinctive surface texture.



More Information

The following resources provide indepth information about fiberboard and plywood.

Books and Journals

APT Bulletin 28, No. 2-3. 1997. Contains three articles on Homasote, Masonite, Beaver Board, and Upson Board.

Bynum, Richard T. 2000. *Insulation Handbook*. New York: McGraw-Hill Professional. Includes chapters on insulation board and historical products, as well as a directory of products with manufacturers and descriptions.

Jester, Thomas C., ed. 1995. *Twentieth-Century Building Materials*. New York: McGraw-Hill. Has individual chapters on fiberboard, plywood, and acoustic materials.

Sellers, Terry, Jr. 1985. *Plywood and Adhesive Technology*. New York: Marcel Dekker, Inc., Addresses the history, manufacture, and applications of plywood.

Other Resources

American Fiberboard Association

853 North Quentin Rd. No. 317

Palatine, IL 60067

Phone: 847-934-8394

E-mail: afa@fiberboard.org

Web site: <http://www.fiberboard.org/>



APA—The Engineered Wood Association

7011 South 19th Ave.

Tacoma, WA 98466

Phone: 253-565-6600

E-mail: help@apawood.org

Web site: <http://www.apawood.org/>

Composite Panel Association

18922 Premiere Ct.

Gaithersburg, MD 20879-1574

Phone: 301-670-0604

E-mail: info@pbmdf.com

Web site: www.pbmdf.com

Forest Products Laboratory

One Gifford Pinchot Dr.

Madison, WI 53726

Phone: 608-231-9200

Web site: <http://www.fpl.fs.fed.us/>

Hardwood Plywood & Veneer Association

1825 Michael Faraday Dr.

Reston, VA 20190

Phone: 703-435-2900

Web site: <http://www.hpva.org>

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Some of the historical information in this tech tip came from the Plywood Pioneers Association Web site, <http://www.apawood.org/plywoodpioneers/>.

About the Authors

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Kathleen Snodgrass came to MTDC as a project leader in 2001. She graduated from Washington State University in 1974 with a bachelor of science degree in architectural studies and then spent about 10 years in highway design and construction with the Idaho Division of Highways. She began her career with the Forest Service in 1984. Kathie worked in facilities, landscape architecture, land line, and general engineering on the Nez Perce National Forest for around 10 years and was the forest's facilities architect for about 7 years before coming to MTDC.

Library Card

Wilson, Richa; Snodgrass, Kathleen 2007. Early 20th-century building materials: fiberboard and plywood. Tech Tip 0773-2308-MTDC. Missoula, MT: U.S. Department of Agriculture Forest Service, Missoula Technology and Development Center. 10 p.

This is the second in a series of tech tips about innovative building materials developed in the first half of the 20th century that were commonly incorporated into Forest Service buildings. It provides practical information to help engineers, persons working in the heritage program, and others maintain and preserve historic facilities that contain fiberboard and plywood. It describes the history of fiberboard and plywood, their manufacture, and their physical characteristics. It addresses common problems encountered with fiberboard and plywood and provides guidance on their maintenance, repair, and replacement.

Keywords: Beaver Board, facilities, Feltex, fiberboard, Fir-tex, hardboard, heritage, historic buildings, historic preservation, history, Homasote, insulation, maintenance, Masonite, Nu-Wood, plywood, Upson Board, veneers

Additional single copies of this document may be ordered from:

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E-mail: wo_mtdc_pubs@fs.fed.us

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E-mail: ksnodgrass@fs.fed.us

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<http://fsweb.mtdc.wo.fs.fed.us/search/>



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