INCLINE RAILWAY

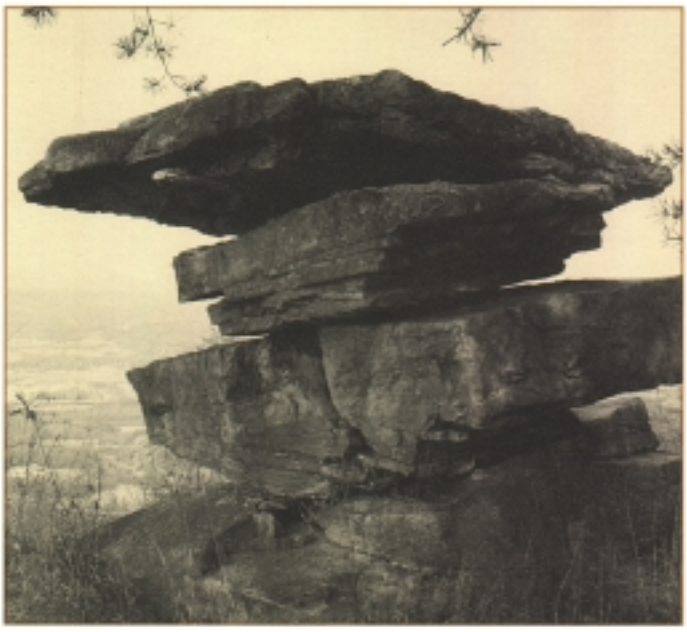
100th National Historic Mechanical Engineering Landmark

Chattanooga and Lookout Mountain, Tennessee
11 September 1991

Conquering Lookout Mountain is a classic story of man's quest to reach the summit of an imposing mountain; however, it was not the mountaineer's goal to reach the summit merely because it was there. It was, instead, the goal of developing the mountain because of its potential tourist revenue. The development was accomplished with the aid of rail transportation, establishing tourism as the largest industry in Chattanooga.

Early view of Lookout Mountain

Competition included two incline railways plus a broad gauge (4' 8 1/2" between rails) railroad. The winner was the one which could reach the summit the fastest—the existing Incline #2. Construction challenges were overcome with innovative engineering solutions. Longevity of the Incline in Chattanooga was achieved by recognition that tourists were the major customers and that safety of operation was of paramount importance.



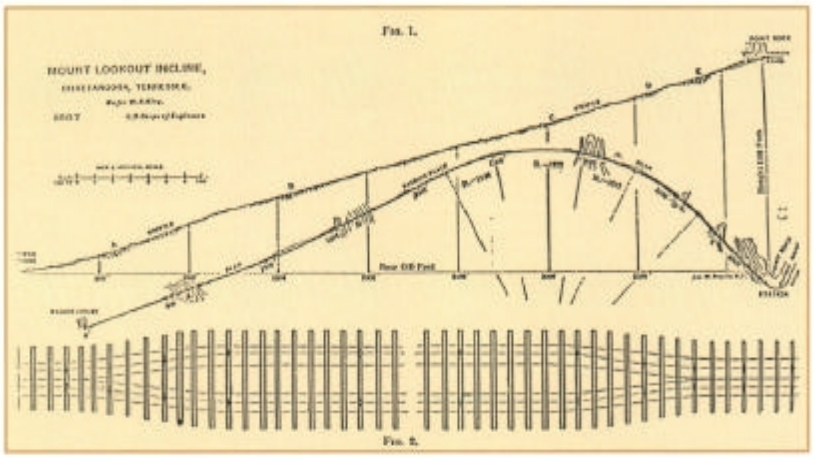
Umbrella Rock

Historical Significance

The peculiar formation of Lookout Mountain, rising 1500+ feet above Chattanooga, formed a natural attraction with a panoramic view unsurpassed east of the Rocky Mountains. Residents of Chattanooga recognized its immense advantages as an adjunct to the city and for its pure hygienic resources. To exploit this opportunity, Colonel James A. Whiteside constructed a toll turnpike to the summit in 1852, and in 1857 built the first hotel. Other hotels followed. The mountain's fame spread and wealthy plantation owners and others flocked to the cool resort from the Atlantic coast, New Orleans, Memphis and other points. Many natural rock formations such as Lookout Point, Umbrella Rock, Old Man of the Mountain, Rock City and, later, Ruby Falls, as well as the site of the Civil War's "Battle Above the Clouds" added to the scenic beauty and interest. It also offered a lower incidence of summer disease than the coastal plains.

After the Civil War, a competing turnpike, the St. Elmo Turnpike, was built in 1879 at a much easier grade with the toll set at one-half that of the Whiteside road. The Whiteside Turnpike was one of Harriet Whiteside's few sources of income after the Civil War, during which her hotel burned. She therefore began charging admission to what is now Point Park overlooking the Tennessee River's Moccasin Bend. An exclusive contract with one livery service provided additional income. This policy outraged many visitors, but a court battle in 1883 ended with the judge ruling in favor of the Whiteside family, upholding the right of a property owner to selectively exclude anyone he desires from his property.

A group of investors planned to retaliate by building an incline railway to a point below the bluff at Lookout Point and constructing a four story hotel that would provide as good a view as that from the bluff. To reach the summit without traversing the Whiteside property at the point, a narrow gauge (3' between rails) railroad, would be constructed around the back side of the mountain, reaching the summit near Sunset Rock. During the same period, a cog railroad was proposed by the president of the Nashville & Chattanooga Railroad, J. W. Thomas. A wealthy Nashvillian, Colonel E. W. Cole, was enlisted to invest in the venture. The latter plan fell through when property purchase arrangements with Mrs. Whiteside collapsed. Either railway would have provided a fast, direct transportation link to the top of the mountain, which was believed necessary to develop the mountain area into a summer resort.



Plan and Elevation of Incline #1

It was first necessary to rapidly transport people from downtown Chattanooga to St. Elmo at the base of Lookout Mountain. A streetcar line using horsecars was thus incorporated from Chestnut Street to the Georgia state line and completed by the end of 1885.

The "Turnpike War" was rekindled again in March, 1885, when the Tennessee legislature passed a bill which prohibited discrimination against any liveryman at any public place of resort. On July 25, 1885, Mrs. Whiteside and liverymen employed by her were found in contempt of court and were ordered to open the gates of the Point to all.

Because of the Whiteside Turnpike, a straight route up the mountain for the incline was not feasible. Major W. R. King, stationed in Chattanooga with the Army Engineering Department for Tennessee River Improvements, then concocted a plan for a rail line to the summit. The first Incline railway would start north of the Whiteside Turnpike

Lower Station of Incline #1

and go straight up the side of the mountain. After the passing tracks, it would gradually curve to the right in an almost 90° curve to reach the base of the bluff. The maximum grade was 33%, and the open-sided, low center-of-gravity, cars provided a spectacular, if scary, ride. The maiden trip was made on March 12, 1887, and the Point Hotel was officially opened May 28, 1888. The completion date for the Narrow Gauge railway was July 1, 1887. This railway was extended to Natural Bridge and a hotel was built there by September, 1889.

Prior to completion of Incline #1, competition emerged in February, 1887, with the formation of a company to construct a broad gauge railroad up Lookout Mountain. The Broad Gauge would allow passengers to embark in major cities such as New Orleans or New York and step from the train at a station atop Lookout Mountain. The right-of-way began at St. Elmo, going slowly up the mountain and on a trestle over Incline #1 to a switchback on the back side of the mountain and then to the summit at some distance south of the Point. It then traversed several trestles and ended just south of the Point on the east brow. It was felt that this railroad would be much more convenient, eliminating a horsecar ride from downtown, a two-block walk to the Incline station, the ride on the Narrow Gauge Railroad and the open-air Incline cars which traversed high, wooden trestles.

Surveys were begun in March, 1887, and the line was opened on May 29, 1888, just a day after completion of Point Hotel. To further spur interest in the Broad Gauge, acreage had been purchased on the mountaintop and a large land sale was held at the opening with free passage.

Narrow Gauge Railroad

Incline #1 intensified competition by offering 15-minute service daily and ten-minute headway service on Sundays. For one dollar, a patron was offered round-trip passage plus a full-course meal in Point Hotel. This package was countered by a plan to build another stylish hotel a few blocks south of the Point. The Broad Gauge extended its line to a spot in front of the planned hotel in June, 1890. Incline #1 countered the competition by extending

the Narrow Gauge line to Natural Bridge on September 28, 1889.

The Broad Gauge Railroad and the 365-room Lookout Inn were marginal operations—sometimes open, sometimes not. The cost of operating the railroad was probably high, and the Inn had to sustain itself on a seasonal summer trade. Point Hotel recognized that it could not compete with Lookout Inn, and dual rail was laid from Natural Bridge to the Lookout Inn, benefiting both the Narrow Gauge/Incline #1 and Broad Gauge lines. The opening of this line was March 2, 1894.

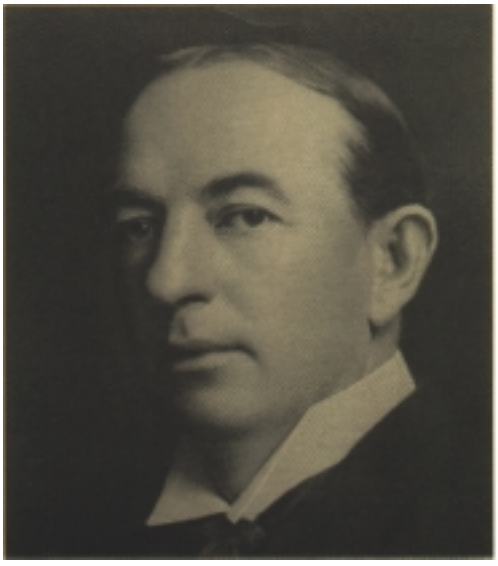
Point Park Hotel and Cravens House

John T. Crass, a railroadman, realized that neither the Broad Gauge nor Incline #1 provided fast, efficient service to the top of the mountain. He envisioned a line which would go straight up the mountain to the Lookout Inn. A charter application was filed for Incline #2 on June 1, 1895, by an historical list of investors: John T. Crass, the Whiteside family, Jesse Cravens, Lynn White, and Jo Conn Guild, Sr. They also proposed a street railway at the crest to reach Lula Lake and the now Rock City area.

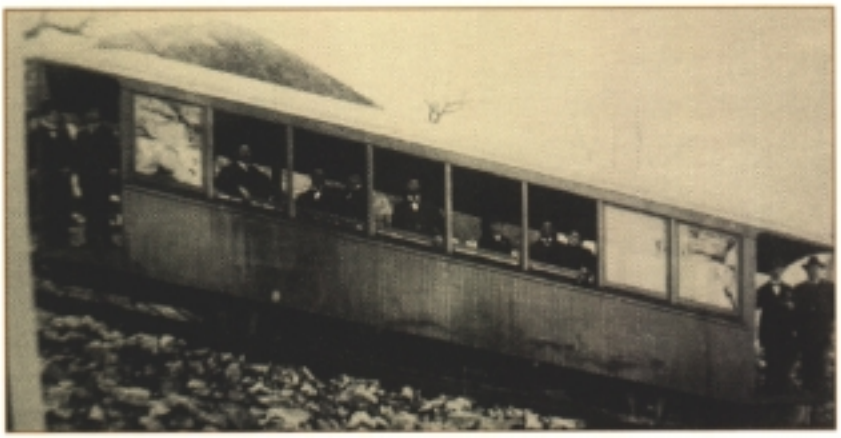
Incline #2 was designed by Josephus Conn Guild, Sr., and Lynn White. Mr. Guild was a civil engineering graduate of Vanderbilt University in 1883. He later designed and built Hales Bar Dam on the Tennessee River, among the first hydroelectric facilities built on a navigable waterway. He also constructed over one hundred municipal waterworks and sewage systems through the south.

The clearing of right-of-way for Incline #2 was begun on June 20, 1895, and service was inaugurated on November 16, 1895. A 100- foot cut had to be made at the bluff, and hand-drilling for blasting was necessitated because of the hard sandstone conglomerate. The maximum grade reached was 72.7 percent. To reduce competition from Incline #1, Harriet Whiteside had stairs that connected the Point Hotel with Lookout Point removed on November 20, 1895.

Squabbles ensued among the three railroads, and the hotels were sometimes open and sometimes closed. A disaster struck Incline #2 on the night of December 12, 1896, when fire



Jo Conn Guild, Sr.



Inaugural Trip of Incline #2

engulfed the upper station and sent the upper car, on fire, shooting down the mountain and destroying itself. Mr. Crass obtained a replacement car from the Chattanooga Car & Foundry Co. and reopened the line March 4, 1897.

Rate wars continued, and Lookout Inn was intermittently closed. Clearly the mountain could not support three railroads and two or three hotels. The Broad Gauge took sixty minutes to reach the summit from downtown Chattanooga and Incline #1 took fifty minutes, but Incline #2 provided a 22-25 minute ride. J. T. Crass created a sensation in order to satisfy out-of-town investors in the Broad Gauge when he purchased the Broad Gauge on October 13, 1897, for a total of $15,000. The entire line was refurbished with a plan to extend the line to Rock City area and Lula Lake and to electrify it. This modification never occurred.

On January 4, 1898, Incline #1 was purchased by one of the original investors, Mr. K. M. Marshall, and reopened on April 25, 1898. On May 2, 1898, the mountaintop portion of the Broad Gauge was electrified. Incline #1 countered by leasing the Point property on July 25, 1898, until the Federal Government acquired the land for a national military park. Stone steps from Point Hotel to the Point were restored and it was announced that only patrons on Incline #1 would be allowed access into Point Park. Mrs. Whiteside was infuriated, and this action persuaded her to sign the necessary papers with the Federal Government to open Point Park to all on September 30, 1898. In December the Point became public property of the United States Government.

On June 30, 1899, J. T. Crass, promoter of Incline #2 and also the owner of the Broad Gauge, acquired for a mere $70,000 the Narrow Gauge railroad and Incline #1 in a tremendous coup. Despite a plan to convert Point Hotel into a concert hall and beer tavern, Incline #1 ceased to operate after July, 1899. J. T. Crass then converted the Narrow Gauge line to Standard Gauge in December, 1899, and electrified the remaining portion of the line to the Point Hotel. With the cost of electrifying the Broad Gauge down the mountain prohibitive, its track was sold for scrap in 1900.

Mr. Crass had solved his excess capacity problem by buying out his competitors and closing them.

In 1911, Incline #2 was electrified. The Otis elevator control, a centrifugal governor, was probably installed on both the cars and the powerhouse cable drums at this time.

The succeeding Chattanooga Railway & Light Co., which had acquired the lines on the mountain, streetcar lines in the valley, and the city's electric com-

pany, decided to put an electric streetcar up the mountain on the roadbed of the Broad Gauge, and this line was opened on September 1, 1913. Financial success did not ensue, but its usefulness was demonstrated after a second fire at the upper Incline station on March 23, 1919. One of the Incline cars again burned and crashed down the mountainside, destroying itself. A replacement car was built by the Chattanooga Railway & Light Co., and the Incline was reopened on December 31, 1919. The surface line up the mountain was not used after February 25, 1924.

The final competition to the rail lines on the mountain was the first paved road up the mountain, Scenic Highway, which was probably completed shortly before August 28, 1928, when bus service was inaugurated and trolley service eliminated on top of the mountain. Ironically, the automobile ensured Incline #2's continued operation because of the three million visitors they brought to Chattanooga each year. It is significant that Incline #2 continued to operate as a private corporation by the Southern Coach Mfg. Co., until January 28, 1973, when it became part of the Chattanooga Area Regional Transportation Authority.

Attention to the consumer is illustrated by periodic replacement of the Incline cars. Original cars were replaced in 1911 by Kuhlman built cars from Cleveland, Ohio, which did not have open platforms on each end. In December, 1949, these cars were replaced with sleek, streamlined cars (though they never exceeded a speed of 8 m.p.h.) built by Southern Coach Mfg. Co. in Evergreen, Alabama. They used the Kuhlman car under-bodies. Most recently, nostalgically designed, wooden streetcar replicas were purchased in 1987 from Hall Corp. in Pittsburgh. One of the 1949 cars is on display at the Tennessee Valley Railroad Museum. Upper and lower Incline stations have also been periodically replaced and modernized.

Burned Incline Car - 1919

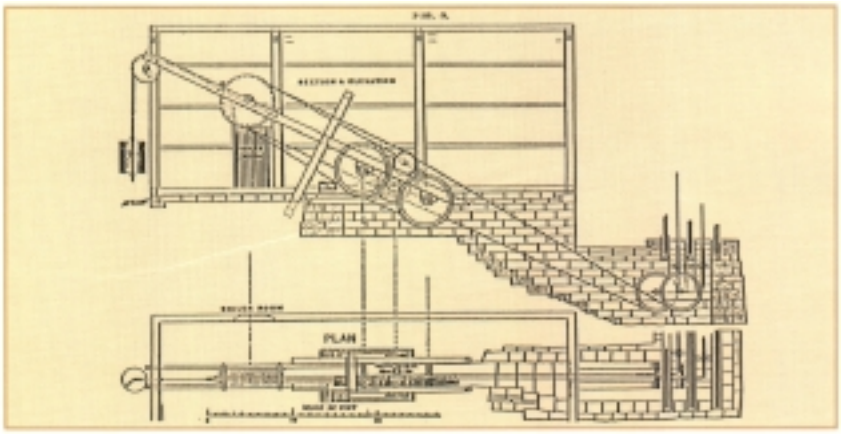
A very significant design consideration for both Inclines was the safety of patrons. As a result of this safety emphasis, neither Incline has had a passenger fatality to date.

Features Which Set This Work Apart From Similar Landmarks

1. Innovative Design Features:

A. Incline #1

(1) A three-rail roadbed throughout, except at the passing tracks, for improved stability on the treacherous mountain grade



Incline #1 Powerhouse Schematic

placed to the side of the roadbed and away from the hotel foundation

B. Incline #2

(1) A three-rail roadbed on the upper half of the Incline for improved stability on the treacherous mountain grade

(2) A nearly constant grade of 27% which permitted cable pulleys to be set at a 45° angle to accommodate curves in the roadbed

(3) Two curves in the roadbed—one of 8° and one of 80°

(4) Right angle layout of the steam engine and driving pulleys with the roadbed, permitting the boiler room to be located in the back of the lower Incline station and engines and driving pulleys under the main floor of the station

(5) Powerhouse located at the bottom of the mountain with a lower driving cable attached to the cars since there was no room for a powerhouse at the top of the mountain

(6) Instead of spikes, the rails were secured by heavy 5" lag screws, the heads of which were secured by 2" x 3" wrought iron washers which gripped the base of the rail.

(7) An 8' diameter cable pulley at the top conveniently

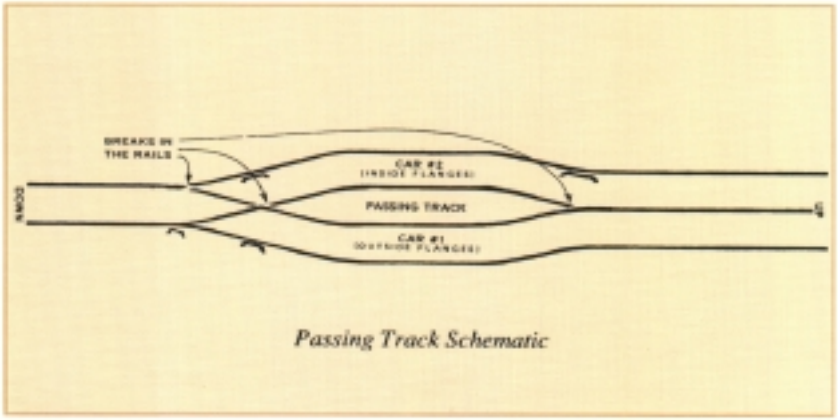
(2) Automatic switching at the passing tracks by the use of outside flange wheels on one car and inside flange wheels on the other which eliminated moving parts

(3) Trestles built without drift bolts in order to make repair easier

(4) Ties held in place with 3/4" x 5" dowel pins

(5) For 900' on the upper end, ties are laid on stringers which are supported on cross sills bedded in rock.

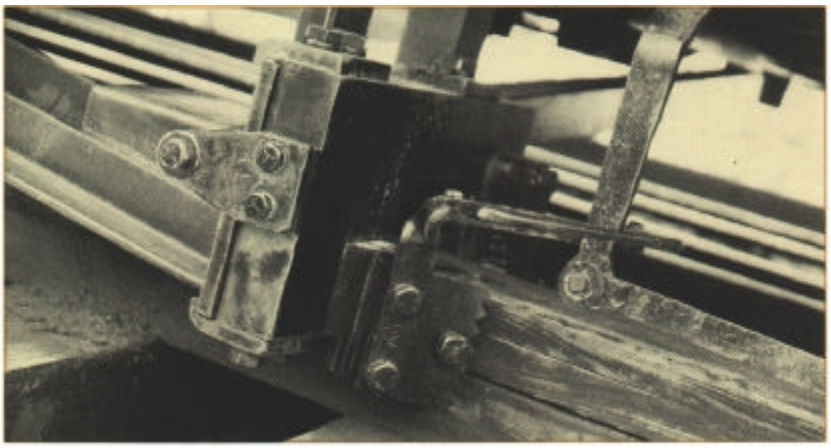
(6) Track construction on the upper portion is an extension of the deck system of the trestles with sills bedded in broken stone taking the place of bents, giving a stiffer and substantial



Passing Track Schematic

Incline #2 Passing Tracks

track construction, effectively keeping the alignment and surface and reducing the tendency to creep down grade. Stringers were anchored by rods to eye bolts drilled into solid rock.



Incline #2 Guard Rail Clamps

(7) The Incline cars were constructed with an internal, stepped slope of about the average grade of the railway.

(8) Take-up pulleys to allow for expansion and contraction of the cable were eliminated by designing the lower station to accommodate stopping of the lower car anywhere within fifty feet.

(9) The cable clamp on each car can revolve so that any difference in length of the two cables is adjusted and the tension is kept equal in each cable.

(10) The cars are designed for a specific maximum weight so that cable sag over the large change in grade will ensure that cables always sag to the guide pulleys over their entire travel.

(11) The grade is such that equal loads approximately balance each other at all points on the line. The car at the lower end which is at the minimum grade has the whole length of cable attached to it, but to counterbalance this combined weight, the car at the upper end stands almost on the maximum grade.

2. Safety Features:

A. Incline #1

(1) Low center-of-gravity cars

(2) A design factor of 10 for the upper cable

(3) The engineer in the engine house tower had an unobstructed view of the cars at nearly all points on the line.

(4) Telegraphic communication used an 8-cell Leclanche battery in the engine room. One pole was connected to a bearing of the main sheaves and thus with the cable. The other pole was connected through the magnets of the gong to an ordinary telegraph wire stretched between the rails and six inches above them and supported by insulators that did not rise above the wires.

The circuit was completed by pressing a spring upon the wire with the other end of the spring connected to the cable where it was attached to the car. To guard against failure to make the proper signal when in motion, it was understood that any signal except one meant “stop.” The “start” signal was such that it could hardly be counterfeited.

A. **Incline #2**

Incline #2 Powerhouse

(1) Double cables

(2) Two 5" x 6" wooden guard rails were laid on the inside of the rails to prevent derailment and to act as a safety rail. Cable clamps on the cars are designed to revolve around a 2-1/2" king pin according to which cable is the shorter. If either cable breaks or unduly stretches, the clamp advances to the limit and a trigger is struck which operates the safety brake. This brake consists of two cast iron slides with toothed faces which are pressed together by coiled springs. On the second and succeeding sets of cars, the guard rails were moved to the outside of the rails and a centrifugal governor installed to activate the safety brakes at a car speed of eight miles per hour.

(3) Two strap brakes on the winding drums were controlled by the engineer in the engine house and were worked by a hand lever. The levers were later controlled by centrifugal governors.

(4) In addition to the hand throttle wheel, there was a foot lever controlling a second quick cut-off steam valve. This valve is also cut off by the upper car striking a lever if it runs beyond the point at which it is intended to stop.

(5) An overhead trolley wire communication system was utilized with a separate gong and different tone for each car in the engine house. In the early 1900's, this system was replaced with grade-level wires and a metallic pole for tapping the wire on each car. Two-way radios were added in the 1970's, but conductors continued to use the simpler metallic poles until 1987 when the wires were removed at the time of the installation of the new cars.

(6) A signal wire and telephonic connections between the upper and lower stations

(7) Continued modernization has been accomplished over the years. The steam engines were replaced by two 100 hp electric motors in 1911 and a completely electronic control system was installed in 1987.

Mechanical Specifications

Incline #1

Length 4360'
Elevation 1170'
Number of Trestles 6
Maximum Grade 33%
Largest Curve 80°
Gauge 3'
Steel Cable 1-1/4"/1"
Boilers 75 psig
Steam Engines 2-12" x 18"-Wheland Foundry
Cost $350,000
Rail 25#

Incline #2

Length 4972'
Elevation 1450'
Number of Trestles 6
Maximum Grade 72.7%
Gauge 4'8-1/2"
Steel Cable (2) 1-1/4"
Boilers 2@80 hp each - Walsh & Weidner
Steam Engines (2) 775 hp-Wheland Foundry
Electric Motors (2) 100 hp-(1911)
Rail 56#

Current Incline #2

The Lookout Mountain Incline Railway is the 100th National Historic Mechanical Engineering Landmark to be designated. Since the ASME Historic Mechanical Engineering Recognition Program began in 1971, 146 Historic Landmarks, 6 Heritage Sites, and 3 Heritage Collections have been recognized. Each reflects its influence on society, either in its immediate locale, nationwide, or throughout the world.

An ASME landmark represents a progressive step in the evolution of mechanical engineering. Site designations note an event or development of clear historical importance to mechanical engineers. Collections mark the the contributions of a number of objects with special significance to the historical development of mechanical engineering.

The ASME Historic Recognition Program illuminates our technological heritage and serves to encourage the preservation of the physical remains of important works. It provides an annotated roster for engineers, students, educators, historians and travelers. It helps establish persistent reminders of where we have been and where we are going along the divergent paths of discovery.

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