

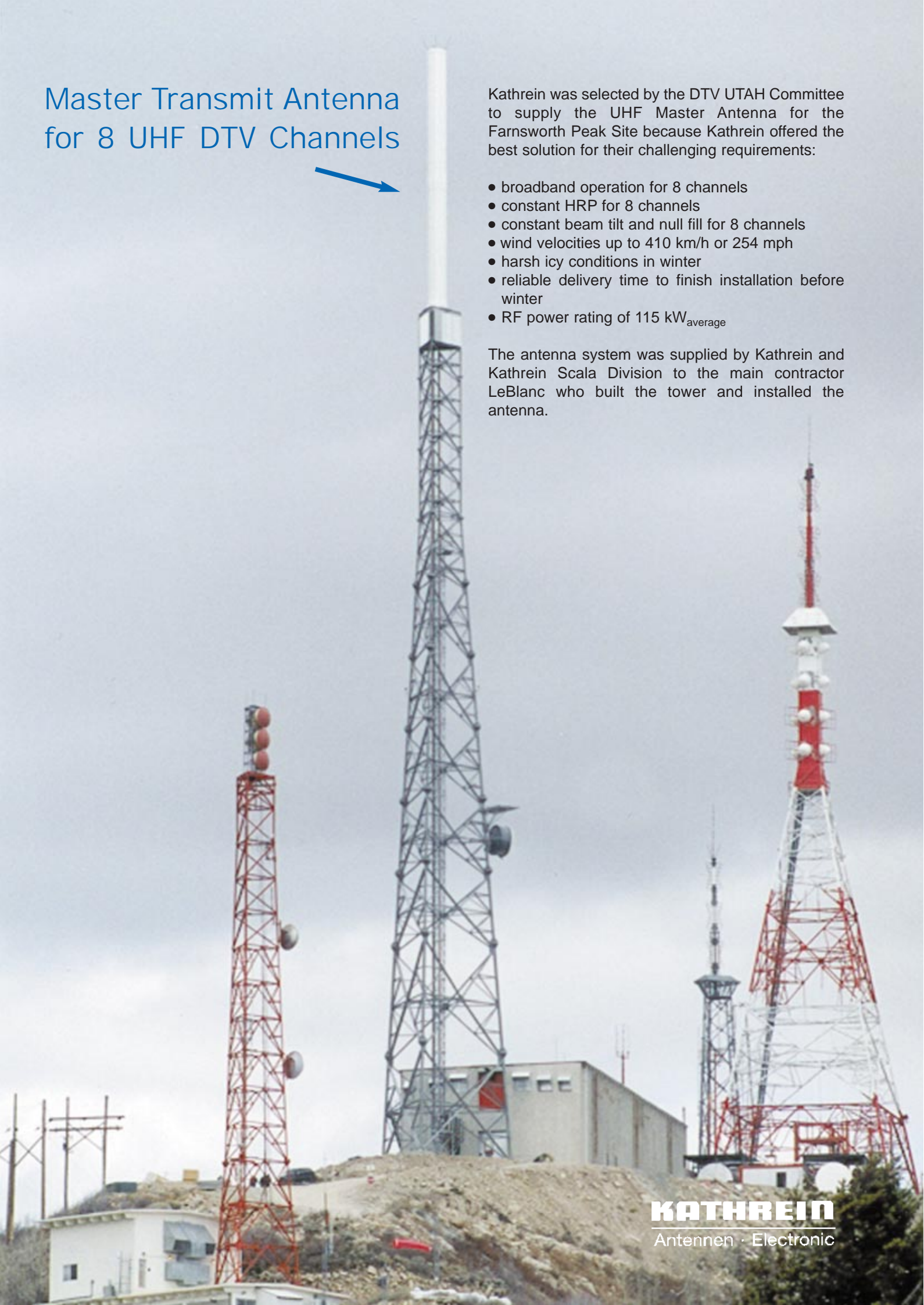
## Master Transmit Antenna for 8 UHF DTV Channels



Kathrein was selected by the DTV UTAH Committee to supply the UHF Master Antenna for the Farnsworth Peak Site because Kathrein offered the best solution for their challenging requirements:

- broadband operation for 8 channels
- constant HRP for 8 channels
- constant beam tilt and null fill for 8 channels
- wind velocities up to 410 km/h or 254 mph
- harsh icy conditions in winter
- reliable delivery time to finish installation before winter
- RF power rating of 115 kW<sub>average</sub>

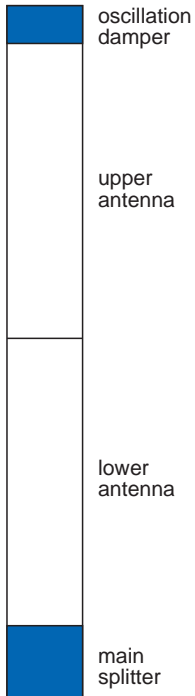
The antenna system was supplied by Kathrein and Kathrein Scala Division to the main contractor LeBlanc who built the tower and installed the antenna.



## 1. Project Schedule

|                            |   |
|----------------------------|---|
| February 1999              | Order<br>Clarification of details and matching antenna to tower<br>Production of components |
| June                       | Installation of antenna inside radome   |
| July 9 <sup>th</sup>       | In-plant tests completed successfully<br>Shipment of two 40' containers                     |
| August 10 <sup>th</sup>    | Containers arrive in Salt Lake City   |
| August 28 <sup>th</sup>    | Antenna installed on the tower<br>Installation of 16 bay feeders                            |
| September 10 <sup>th</sup> | Antenna commissioned and ready for operation  |

## 2. Design of Antenna System and Specifications



The antenna system consists of 2 identical 8 bay antennas to give maximum redundancy of operation (any channel can be operated either on upper or lower antenna) and freedom for the design of the combiner system.

The UHF panel arrays are mounted inside a structural self-supporting fiberglass radome with a diameter of 1.6 m or 5 ft. and which is split into 2 sections (to fit into containers for shipment).

An oscillation damper to suppress KARMAN oscillations is installed at the tip of the upper section.

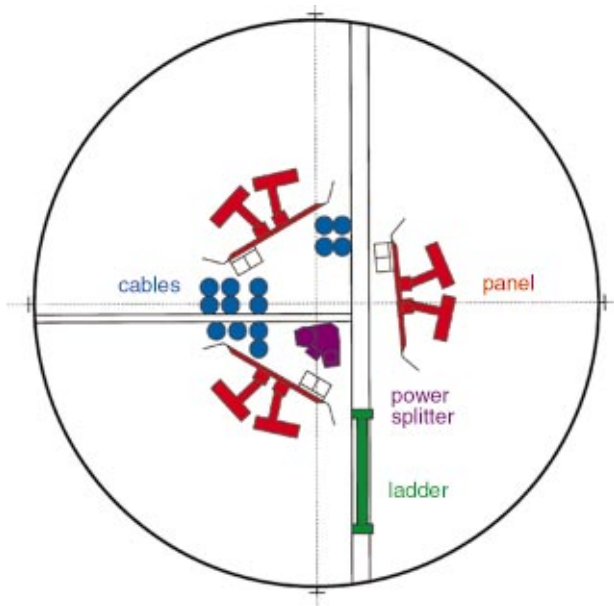
The two 8-way main splitters are mounted in a closed platform below the fiberglass radome to allow easy access.

Four lightning protection rods are run down the outside of the radome to prevent any damage to the radome or the built-in antennas.

### Antenna specifications:

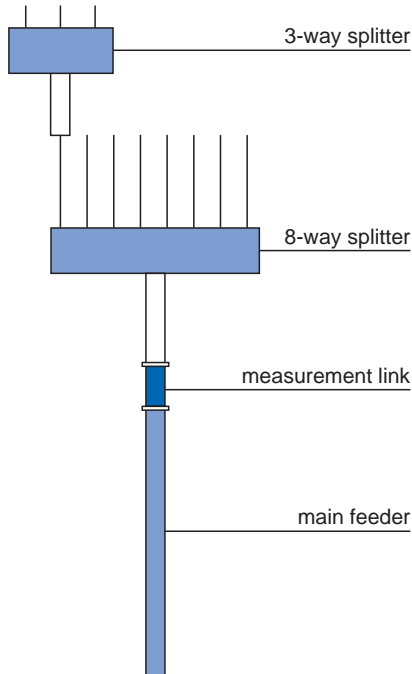
|                 |   |
|-----------------|---|
| input           | 2 x 6 1/8" EIA                          |
| max. RF power   | 2 x 60 kW <sub>average</sub>            |
| input impedance | VSWR < 1.06 across 8 operating channels |

### 3. RF-Details of Antenna System



Each antenna consists of 8 identical bays. One bay is made of 3 dipole panels to form a HRP with 3 main lobes.

**UHF Antenna**  
**Inside Structural Fiberglass Radome**



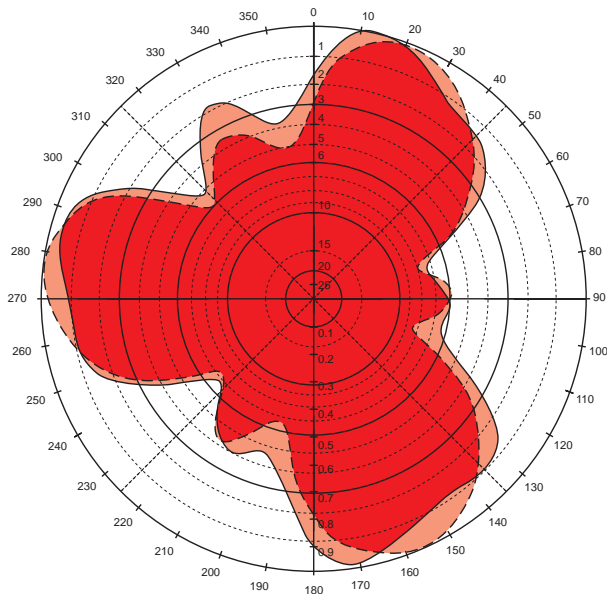
The parallel feed network consists of one 8-way main splitter and eight 3-way bay splitters to provide constant beam tilt and null-fill for all 8 channels.

Measurement links are installed between the end of the feeders and the input of the main splitters to allow quick and accurate measurement of antenna input impedance and electrical length of the feeder without dismantling any part of the feed network.

## 4. Radiation Patterns

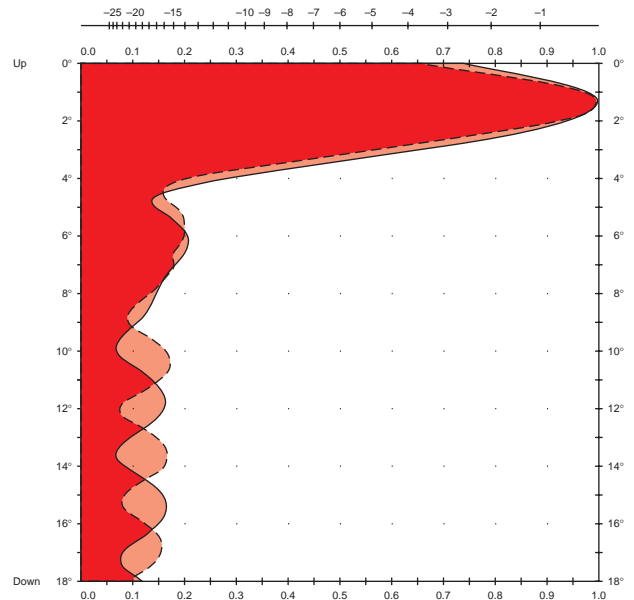
The computed patterns coincide well with the patterns measured in antenna test range.

### HRP comparison between ch. 34 and ch. 48



|                  |                |                |
|------------------|----------------|----------------|
| frequency in MHz | <u>591.250</u> | <u>675.250</u> |
| downtilt in °    | 1.5            |                |
| max / mean in dB | 2.35           | 2.67           |

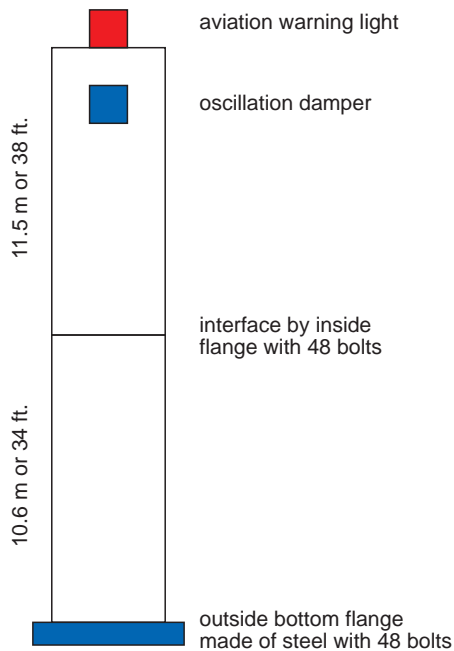
### VRP comparison between ch. 34 and ch. 48



|                  |                |                |
|------------------|----------------|----------------|
| frequency in MHz | <u>591.250</u> | <u>675.250</u> |
| azimuth in °     | 15.0           |                |

Variation of gain between ch. 34 and ch. 48:  $\pm 0.3$  dB

## 5. Mechanical Details



|  |                  |
|--|------------------|
| total height                               | 22 m = 73 ft.    |
| diameter                                   | 1.6 m or 5 ft.   |
| weight of upper section                    | 55 kN or 12,750# |
| weight of lower section                    | 40 kN or 9,000#  |
| radome surface is painted white (UV-proof) |                  |

An oscillation damper to suppress KARMAN oscillations is installed at the tip of the upper section (the performance of this damper is superior to a Scruton spiral because it provides broadband damping without increasing the wind load).

Comfortable and safe access day and night to the top of the cylinder and the antenna is provided by a full size inside ladder and illumination.

## 6. Stability and Reliability of Structural Fiberglass Radomes

Structural fiberglass radomes from Kathrein are providing excellent mechanical stability without need of any steel support.

The radomes can be made with diameters of 0.3 m up to 3 m (1 ft. up to 10 ft.) in sections up to 22 m (72 ft.) in one piece.

Multiple sections can be stacked vertically (for example radome with height 36 m = 118 ft. in 3 sections installed on TV Tower Berlin).

The radomes are designed to withstand high wind velocities (for example at Farnsworth Peak, Utah 410 km/h = 254 mph) and even heavy earth quakes (for example the 31 m = 102 ft. radome on the 405 m TV Tower of Tianjin, China is designed to survive a level 9 earthquake).

Kathrein has supplied 164 antenna systems inside structural radomes (most of them UHF, but also VHF and FM) worldwide.

The radomes have survived all environmental influences. Some of them survived the latest earth quakes in Turkey without damage.

The structural characteristics of every individual radome are tested after production by a non-destructive test.

To show the superior strength of Kathrein fiberglass radomes we decided in 1992 to go beyond the theoretical limit and find out when they break.

The strength of the tested radome was so far above the guaranteed figures that we could not break it at the first attempt because the steel support broke before the radome.

We had to reinforce the steel support before we could finally break the radome.

## 7. Tests

### Factory Acceptance Test:

The HRP and input impedance of upper and lower antenna have been measured before shipment in the Kathrein antenna test range (please see photos).

The HRP matched excellently with the predicted patterns.

The input impedance was well within the specs in all 8 channels.

### Remark:

There is no need to test the VRP of parallel fed antennas, because amplitude and phase of every bay are 100% determined by power splitters and length of bay feeders which are tested individually.

### On Site Tests:

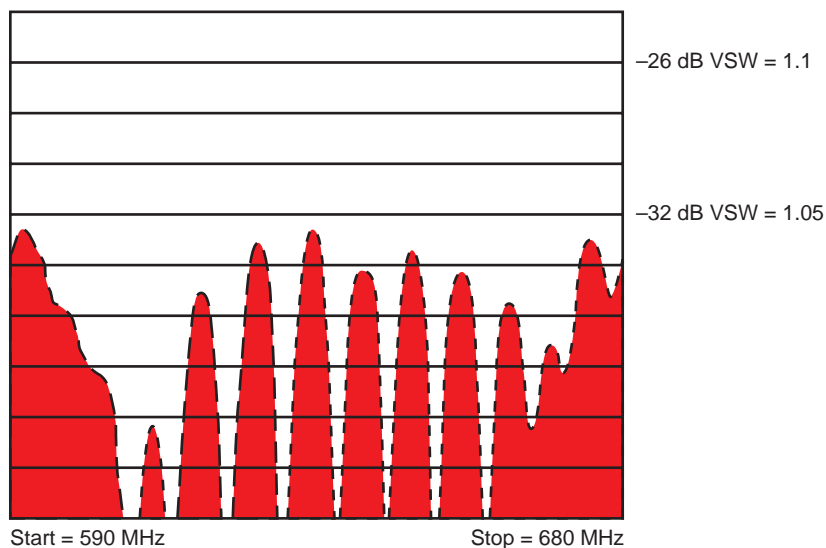
Final tuning of upper and lower antenna and testing was performed within one week.

The return loss at the antenna input of both antennas is better than 32 dB in all 8 channels.

**This allows switching any channel to any antenna without any retuning.**

### UHF Broadband Antenna – Return Loss Measurement

(measured on site)



## 8. Pictures



Antenna mounted on turntable for HRP measurement.  
Ray Carnovale, Greg James, Dirk Freeman.



Antenna in Kathrein factory yard.



Final inspection by management.  
Manfred Muenzel, Dirk Freeman, Greg James,  
Prof. Dr. Anton Kathrein, Ray Carnovale.



Loading antenna into container.