
# Camera Positioning Guidelines for RHP-CT

RHP International, Inc.
www.Rock2000.com

Document referring to:

## RHP-CT 3.1 and earlier

This document is intended to give you hints concerning the following questions:

- How many RHP-CT units will I need to cover my premises?
- Where to put the camera pairs?
- Which lenses to use for the overview cameras?
- How far away may persons or cars be, to still be reliably detected as targets?

If you are in a hurry, read only what's written like this.

# Content

CAMERA POSITIONING GUIDELINES FOR RHP - Camera Tracker ..... 1
1 MOUNTING YOUR CAMERAS ..... 4
2 POSITIONING YOUR CAMERAS ..... 5
3 DETERMINING THE FIELD OF VIEW ..... 7
4 DETERMINING THE OPENING ANGLE ..... 9
5 CHOOSING A LENS FOR YOUR OVERVIEW CAMERA ..... 10
6 HOW TO DISSECT YOUR PREMISES INTO RHP - Camera Tracker ..... 11
6.1 A BIG PARKING LOT ..... 11
6.2 THE FENCE AROUND A BUILDING ..... 13

# 1 Mounting your Cameras

RHP-CT facilitates unattended object tracking using a two-camera system.
Each RHP-CT unit – or each of the two channels of a 19" RHP-CT unit – is connected to one pair of cameras. One of them is a stationary fixed overview camera, typically equipped with a wide-angle lens. The other is a PTZ camera, which can be controlled via serial communication.

RHP-CT analyses the video feed from the overview camera; and whenever it detects a target this way, it will steer the PTZ camera to zoom-in and follow that object.
Therefore RHP-CT must be able to convert the target's position seen in the image from the overview camera into pan/tilt angles for the PTZ camera.
To this end, the user has to calibrate the system interactively during the initial installation procedure of RHP-CT.
But this calibration only works for camera configurations, where both cameras – the overview and the PTZ camera – are roughly in the same place. Therefore:

Both cameras should always be mounted as close together as possible.

The object tracking implemented in RHP-CT is based on motion detection. It relies on the assumption that objects, i.e. potential targets, are moving in front of a stationary background. This assumption will only hold, if the overview camera is mounted solidly enough to prevent shake from wind or vibrations from the PTZ camera operating close by. Therefore:

The overview camera must be mounted as rigidly as possible.

RHP-CT accepts almost any analog video source as an overview camera - they may even be black & white or infrared.

As we are constantly striving to add to the list of supported PTZ cameras, please consult the latest RHP publications or contact support@rock2000.com for the most recent information, whether your intended PTZ camera is among the supported types.

# 2 Positioning your Cameras

Due to the two-camera principle, RHP-CT can only detect targets in the field of view of the overview camera [1].
The remainder of the document will therefore be concerned with the proper positioning and opening angles of these overview cameras.
Of course, at each site of an overview camera, there must also be a PTZ camera.

RHP-CT requires objects to be at least of a certain minimum size, in order to be detected as tracking targets. This means that they must appear big enough in the image provided by the overview camera.

> Currently the minimum target size is 8x16 [2] pixels on a 720x480 input image.

This is the only computational requirement – it is independent of the nature of the objects, their distance from the cameras, or of the focal length of the overview lens used.

A pedestrian (assumed to be taller than wide) must therefore cover [3] at least 8 of the 720 horizontal pixels, which means 8/720 or approx. 1% of the field of view.
The same percentage applies, even if you were tracking tiny mice or huge ships.

> A moving object will be tracked, if it covers at least 1% of the horizontal field of view.

A person approaching the camera is approx. 2 feet wide. A walking person seen from the side moves its arms and legs and should therefore cause motion at least 2 feet wide. Therefore we will be able to track persons, if the field of view of the overview camera is less than 200 feet, which is approx. 60 meters.

> RHP-CT will track persons, as long as the field of view of the overview camera does not exceed 200 feet.

IMPORTANT:

> Whether an object of a certain size will actually be tracked, depends also on its contrast against the background, the illumination and the direction of its movement relative to the camera.
> An object moving directly towards the camera will – while it slowly grows bigger – remain roughly in the same place. This kind of movement is much harder to detect than one leading right across the screen.

[1] RHP-CT allows you to still control the attached PTZ from a normal joystick or keyboard. You therefore retain the full functionality and range of your PTZ.
[2] It can either be 8x16 or 16x8 pixels – the orientation does not matter.
[3] Actually, the object needn't cover the whole 8x16 pixels. Two headlights of a car – each only a few pixels in diameter – will yield a high contrast against the dark background. Therefore they will be triggering an object, as long as they are at least 8 pixels apart.

Low contrast between the background and the object also affects the tracking performance. Camouflage helps to avoid detection; so does darkness.
On the other hand, two tiny position lights of 3x3 pixels each, can lead to a huge contrast against the night-dark background, so that they still may be detected as a moving vehicle.

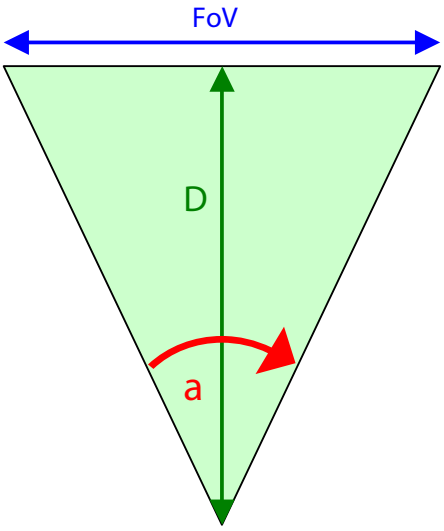
In more adverse situations including noise, small camera vibrations, bad lighting or backlit, a more conservative size for reliably tracking moving objects is when they cover about 1.5-2% of the horizontal FOV.

# 3 Determining the Field of View

The field of view (FoV) of your overview camera depends on two parameters:

- The maximum distance D of targets which must be tracked.
  This could e.g. be the distance from you overview camera to the far end of your parking lot.

- The horizontal opening angle a of the overview camera.
  This angle itself depends on the focal length of the lens and the size of the imager inside your camera ➤ see the next chapter on that.




Mathematically speaking, the field of view FoV can be calculated from the distance D and the horizontal opening angle a according to this formula:

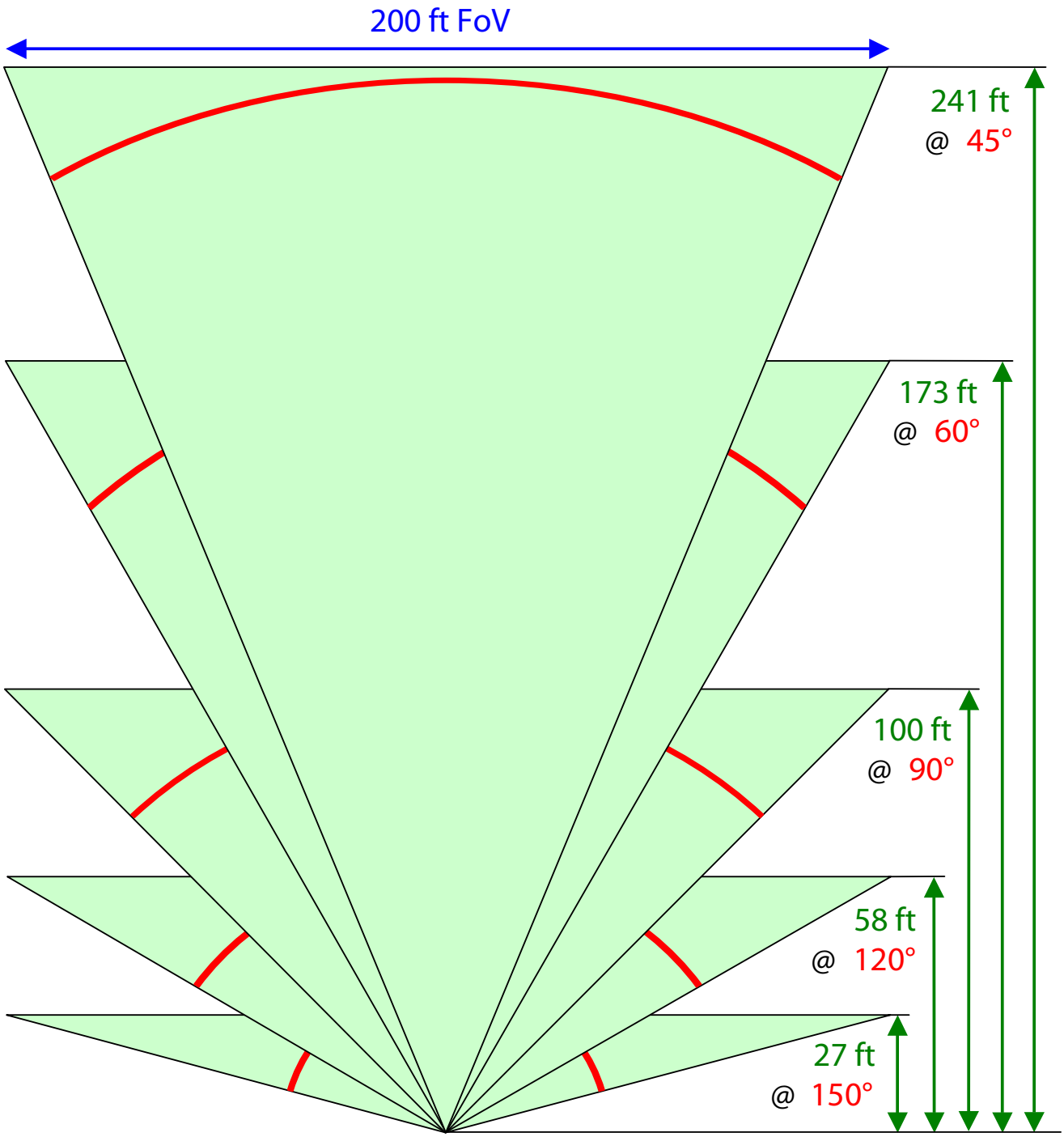
$$FoV = 2 * D * \tan(a / 2)$$

To make things a little more convenient, simply use the following table:

| | 25' | 50' | 100' | 150' | 200' | 300' | 400' | 500' |
|---|---|---|---|---|---|---|---|---|
| 20° | 9 | 18 | 35 | 53 | 71 | 106 | 141 | 176 |
| 30° | 13 | 27 | 54 | 80 | 107 | 161 | 214 | 268 |
| 45° | 21 | 41 | 83 | 124 | 166 | 249 | 331 | 414 |
| 60° | 29 | 58 | 115 | 173 | 231 | 346 | 462 | 577 |
| 90° | 50 | 100 | 200 | 300 | 400 | 600 | 800 | 1000 |
| 120° | 87 | 173 | 346 | 520 | 693 | 1039 | 1386 | 1732 |
| 150° | 187 | 373 | 746 | 1120 | 1493 | 2239 | 2986 | 3732 |

Table 1 : Field of View (in feet) for given horizontal opening angle (in degrees) and max. target distance (in feet)

This table shows the field of view (in feet) depending on the horizontal opening angle and the maximum tracking distance. The combinations where you can expect sufficient resolution to track person-sized targets are highlighted.


200 ft FoV
241 ft
@ 45°
173 ft
@ 60°
100 ft
@ 90°
58 ft
@ 120°
27 ft
@ 150°

# 4 Determining the Opening Angle

Your overview camera actually has three different opening angles: a vertical, a horizontal and a diagonal opening angle.
This is due to the fact, that video cameras produce a rectangular image, which is wider than tall. The following table compares[4] these three opening angles:

| vertical angle | 15° | 22° | 34° | 44° | 67° | 90° | 113° |
|---|---|---|---|---|---|---|---|
| horizontal angle | 20° | 30° | 45° | 60° | 90° | 120° | 150° |
| diagonal angle | 25° | 38° | 56° | 77° | 113° | 148° | 180° |

Table 2 : comparison of vertical, horizontal and diagonal opening angle

For our purposes, we will concentrate on the horizontal opening angle.

The opening angle depends on the focal length of the lens mounted on your overview camera, and on the size of its built in imager.

Most surveillance video cameras used as overview cameras for RHP-CT have a 1/3" imager. Less common, but also in use are ¼" and ½".
The same lens – i.e. the same focal length – will result in a wider opening angle when attached to a ½" imager, and a narrower opening angle when mounted in front of a ¼" imager.
When you know the desired horizontal opening angle, the following table will give you the necessary focal length – assuming a camera with 1/3" imager:

| horizontal angle | 20° | 30° | 45° | 60° | 90° | 120° | 150° |
|---|---|---|---|---|---|---|---|
| focal length in mm | 14.0 | 9.3 | 6.0 | 4.6 | 3.0 | 2.2 | < 2.0 |

Table 3 : focal length (in mm) for given opening angle (in degrees) assuming a 1/3" camera

[4] Data based on information available from www.PELCO.com.

# 5 Choosing a lens for your overview camera

Most typical overview cameras over a variety of lenses to be used with them.

Zoom lenses (also known as Vari-Focal lenses) with variable focal length span a wide range of opening angles. They let you adjust the field of view to exactly what you want to see.

Many CCTV cameras have a feature which allows them to steer the iris of the mounted lens. Lenses with such a controllable "auto iris" cost a little more than ones without, but they enable the best performance of your CCTV camera. Especially when used as an overview camera for RHP-CT, the camera can fully open the "auto iris" at night, in order to prevent unnecessary camera noise. Therefore:

If possible, equip your overview camera with a auto -iris zoom lens.

Many of our customers use the Pelco Spectra III as the PTZ camera for RHP-CT. Although there are other suppliers of overview camera lenses, to them it is convenient to pick the overview lens also from Pelco's array of products.

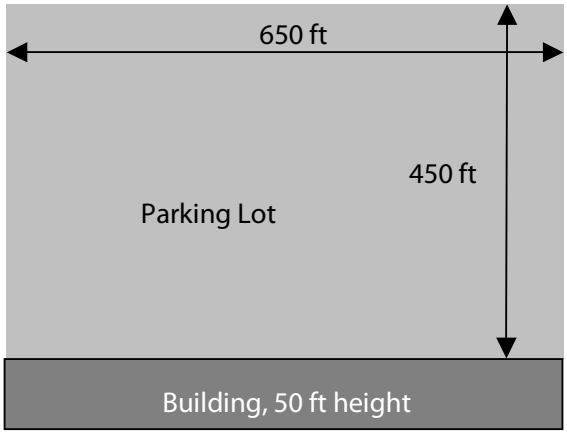
The following table lists recommended Pelco zoom lenses (1/3", CS-mount, auto-iris) for the various opening angles.

| Opening Angle | Use for Angles: | Focal length | Model No. |
|---|---|---|---|
| 180.0°- 84.3° | > 102° | 1.6 - 3.4 mm | 13VD1-3 |
| 107.6°- 45.6° | 102°-92° | 2.5 - 6.0 mm | 13VD2.5-6 |
| 97.4°- 24.1° | 92°-86° | 2.8 - 12.0 mm | 13VD2.8-12 |
| 91.0°- 35.9° | 86°-41° | 3.0 - 8.0 mm | 13VD3-8 |
| 53.6°- 6.5° | < 41° | 5.0 - 40.0 mm | 13VD5-40 |

# 6 How to dissect your premises into RHP-CT-zones

As the field of view for tracking person-sized targets must be no greater than 200 ft, the probem arises, how to dissect the area which is to be monitored into zones of approx. 200 ft FoV.
We will give you hints following two examples:

## 6.1 A big parking lot



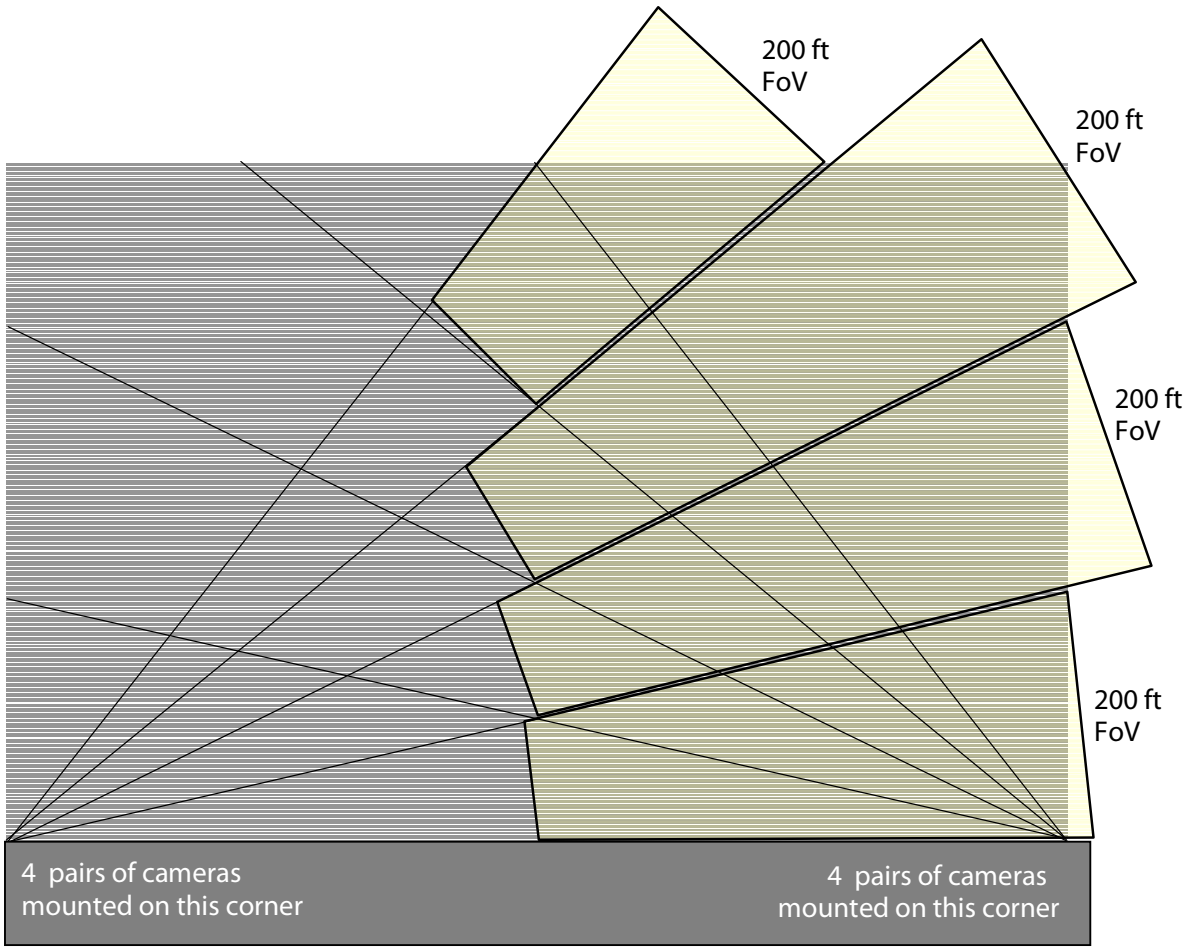

A big parking lot (650x450 ft) had to be completely covered.

The cameras were to be mounted on the roof of the building.

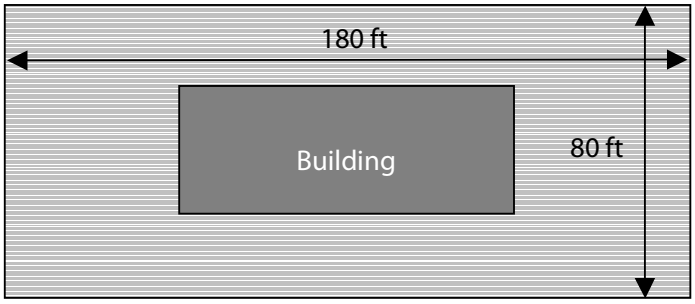
To reduce installation costs, we tried to concentrate the cameras in as few locations as possible.

We came up with the following solution (see next page):

- 8 RHP-CT units with their camera pairs grouped as two sets of 4 each, positioned at the corners of the building
- No overview camera has to cover more than 200 ft field of view – even at the circumference of the parking lot.
- All 8 overview cameras have the same opening angle of 13°, corresponding to a focal length of 21mm.
- Such opening angle to be realized e.g. with Pelco zoom lens 13VD5-40


200 ft
FoV
200 ft
FoV
200 ft
FoV
200 ft
FoV
4 pairs of cameras
mounted on this corner
4 pairs of cameras
mounted on this corner

## 6.2 The fence around a building




The premises (180 x 80 ft) around the building are fenced in.

Cameras are to be mounted on top of the building.

The entire area – not only the fence – is to be covered.

We came up with the following:

- 4 RHP-CT units with their camera pairs positioned at each corner of the building
- No overview camera has to cover more than 200 ft field of
- All 4 overview cameras have the same opening angle of 90°, corresponding to a focal length of 3 mm.
- Such opening angle to be realized e.g. with Pelco zoom lens 13VD2.8-12