Determination of Television Surveillance Camera’s Parameters For a Nuclear Research Facility

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ABSTRACT

In the present study, a distribution and cameras parameter’s calculation of television Surveillance cameras of a hypothetical nuclear research facility is presented. Many cameras’ parameters, which are considered important factors in the design of closed circuit television system should be determined and computed for selecting a suitable camera for a suitable area. Cameras parameter’s formulae will be explained. The work will introduce Cameras Parameter’s Calculation Program (CPCP) as a new and simple computer method for calculating these parameters. Width of images sensitive area, lens focal length, lens format and different angels of view for the cameras will be determined by a CPCP. The work defines cameras locations, fixed and moving cameras numbers and its distribution at the nuclear site according to the physical protection design process. The output results will be analyzed and tabulated.

1-INTRODUCTION

The term ‘closed circuit’ refers to the fact that the system is self-contained, the signals only being accessible by equipment within the system. This is in contrast to ‘broadcast television’, where the signals may be accessed by anyone with the correct receiving equipment. The initial development of television took place during the 1930s, and a number of test transmissions were carried out in Europe and America[1]. The Access Control system restricts / controls movement of people. The CCTV system provides ‘eyes’ to the security system. Cameras are the starting point of the video signal and are therefore a critical component of a CCTV system. The word camera comes from the Latin “camara obscura” and means "dark chamber". Artists in the middle ages used a dark box to trace images. Since then the camera has come a long way. Today there are three types of cameras most commonly used; film cameras, photographic cameras and video cameras. The role of alarms and fence detection systems is to detect movement. The CCTV system has two purposes. The first is to determine the cause of a sensor alarm. This includes determining whether the alarm is a true or false alarm, and the second purpose is to provide information about an intrusion. The CCTV system is composed of several cameras at vital areas, a display monitor at the local end, and various transmission, switching, and recording devices[2]. Many cameras’ parameters, which are considered important factors, in designing CCTV system, should be determined and computed for selecting a suitable camera for a suitable area. These parameters are determined according to areas dimension, locations, lighting, surrounding environment, cost and user requirements. These parameters such as Lens focal length Angle of view, F- Stop number and Width of images sensitive area will be explained and discussed.

2-Closed Circuit Television Systems (CC.TV.S):

The CCTV system is another core subsystem of an overall Security System. It is the collection of cameras, recorders, switches, keyboards, and monitors that allow viewing and recording of security events. CCTV systems for security services include several different functions as Surveillance, Assessment, Deterrence, Facial recognition and Intrusion detection [3].
2.1. Principle of television operation:

A camera is analogous to the human eye and light passing through its lens is changed into an electric signal by means of a charge-coupled device (CCD) or other image sensors that correspond to the eye’s retina. The electric signal is transmitted to a monitor via electrical circuitry. Figure (1) explains the principle of television operation.

![Principle of television operation](image)

**Fig. (1): Principle of television operation**

The monitor’s image is made up of small black and white or red, green and blue dots (or pixels) similar to those that can be seen when a newspaper photo is enlarged. Like these small printed dots, the smallest element the monitor uses to configure an image is called a pixel. In newspaper photos, the size of the dot varies to create light and shade, but in television, the size of each dot remains the same, with shades of lighter and darker dots arranged accordingly. The greater the number of image pixels, the more finely on-screen details can be clearly seen and a high-resolution image can thus be obtained.

2.2. Cameras Shapes and Types:

CCTV cameras are available in various shapes including cylindrical, box, dome and combination dome types, each appropriate for specific applications and purposes. Cameras consist of two main types, color and monochrome (Black and White). There are many different types of cameras according to the working idea such as: High-sensitivity cameras, Infrared cameras, and Thermal cameras.

2.3. Motorized Pan/Tilt Head:

The Pan/Tilt Head systems are used to move cameras to provide a wider coverage of the area under surveillance. They can be rotated by remote control both horizontally and vertically. Horizontal rotation is called "Pan" and vertical rotation "Tilt." “Auto-pan” allows the pan/tilt head to repeat the same panning pattern. Select the type of pan/tilt heads with weight limit capacities appropriate to the camera and lens to be mounted. There are both indoor and outdoor use types.

3. Distribution and Parameter’s Calculations of Television Cameras:

A CCTV system is essential to identify the cause of an alarm and to determine if an alarm is true or false[4]. With a CCTV system, security personnel can rapidly assess sensors alarms at remote locations. The CCTV system has two purposes. The first is to determine the cause of a sensor alarm. This includes determining whether the alarm is a true or false alarm. The second purpose is to provide information about an intrusion. The CCTV system is composed of several cameras at the vital areas, a display monitor at the local end, and various transmission, switching, and recording devices. Major components include: Camera and lens, lighting system, transmission system, video switching equipment, video recording, video monitor, video controller[4].

3.1. Camera Parameter’s Calculations:

Many cameras’ parameters, which are considered important factors, in designing CCTV system, should be determined and computed for selecting a suitable camera for a suitable area. These parameters are determined according to areas dimension, locations, lighting, surrounding environment, cost and user requirements. These parameters include:
• Lens Format,
• Lens focal length calculation,
• Angle of view calculation,
• F- Stop number, and
• Width of images sensitive area

It should be noted that: Monitor Screen Size is an external factor that shares in determining camera parameters.

3.1.1 Lens Format: Length format size defines the maximum usable image created by the lens. Standard lens formats are matched to the format of the camera selected. The 1/4-Inch format will be selected for the exterior cameras which used inside the fence.

3.1.2 Lens Focal Length and Subject Dimensions Calculation:

The focal length is the single most important factor in proper lens selection. It determines the relative magnification of the object. Since the format of a lens is known, the focal length will define the angular fields of view (horizontal and vertical angles covered by lens), thus defining the width and height to the field of view for the camera for any object distance. Figure (2) shows the types of lenses and view field.

![Figure (2): Types of lens and view field](image)

Fig. (2): Types of lens and view field

Lens focal length (mm) of the camera can be obtained from the formulas (1):

\[ W = \frac{A}{f} \times L \text{ (m)}; \quad H = \frac{B}{f} \times L \text{ (m)} \]  

(1)

Where:

- **W**: Width of subject
- **H**: Height of subject
- **f**: Lens focal length (mm)
- **L**: Distance between subject and camera (Figure (2))

**A, B**: Width and height

Table (1) determine the constants A,B according to CCD size.

<table>
<thead>
<tr>
<th>CCD Size</th>
<th>Constant for Width (A)</th>
<th>Constant for Height (B)</th>
<th>Diagonal</th>
</tr>
</thead>
<tbody>
<tr>
<td>1/4&quot; Type</td>
<td>3.2</td>
<td>2.4</td>
<td>4mm</td>
</tr>
<tr>
<td>1/3&quot; Type</td>
<td>4.8</td>
<td>3.6</td>
<td>6mm</td>
</tr>
<tr>
<td>1/2&quot; Type</td>
<td>6.4</td>
<td>4.8</td>
<td>8mm</td>
</tr>
<tr>
<td>2/3&quot; Type</td>
<td>8.8</td>
<td>6.6</td>
<td>11mm</td>
</tr>
<tr>
<td>1&quot; Type</td>
<td>9.5</td>
<td>12.7</td>
<td>15.9mm</td>
</tr>
</tbody>
</table>
3.1.3 Angle of View Settings and Lens Selection:
The angular range covered by a camera is referred to as its “angle of view” and is determined by the focal length of the lens and the size of the imager (CCD) on which the picture is formed. 

**Note:** For multiple lenses with identical focal lengths, the angle of view will not match if the size of the cameras CCD is different. This described in figure (3).

![Diagram](image)

Fig. (3): Angle of view.

CCD screen sizes are available in 1/4", 1/3", 1/2" and 2/3" types, measured based on its diagonal dimension. This difference in size makes almost no difference in terms of performance, but it does change the range of the view field. Figure (3) shows the formulas for calculating field range.

3.1.3.1 Angle of View Calculation:
The angular range covered by a camera is referred to as its “angle of view” and is determined by the focal length of the lens and the size of the imager (CCD) on which the picture is formed. The angle of view is expressed by the following formula (2):

\[
\theta = 2\tan^{-1}\left(\frac{1/2}{f}\right)
\]

Where:

- \(\theta\): Angle of view
- \(I\): effective dimension of CCD (mm)
- \(f\): Lens focal length[7]

The angles of view for different lenses are listed in the specification sections of catalogs. Generally these are as shown in Table (2); many type of lenses as: Fixed Focus Lens, Varifocal Lens, Motorized Zoom Lens, A Spherical lens, Pin Hole Lens, and Prism Lens

<table>
<thead>
<tr>
<th>Type of lens</th>
<th>Angle of View (Horizontal)</th>
<th>Angle of View (Vertical)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Standard lens</td>
<td>30 – 40°</td>
<td>20 – 30°</td>
</tr>
<tr>
<td>Wide angle lens</td>
<td>55 – 60°</td>
<td>45 – 50°</td>
</tr>
<tr>
<td>Super wide angle lens</td>
<td>Over 60°</td>
<td>Over 70°</td>
</tr>
</tbody>
</table>

3.1.4 F-Stop Number:
**F-number:** An important lens parameter is its aperture setting called an f-stop, which is the lens' measure of its ability to gather light. The smaller the f-stop, the light is admitted; therefore, a small f-stop (1.2 to 1.8) is desirable for exterior assessment applications. The f-stop sometimes called the focal ratio, f-ratio, f-stop, or relative aperture. The number is the ratio of the lens focal length to the aperture
opening in mm (the diameter of the entrance pupil or effective aperture) see table (3). Ignoring differences in light transmission efficiency, a lens with a greater f-number projects darker images

\[ F - \text{Number} = \frac{\text{Focal Length}}{\text{Lens/Aperture Opening in mm}} \quad (3) \]

**Table (3) Camera Format and Aperture Opening in mm**

<table>
<thead>
<tr>
<th>Camera Format</th>
<th>1/4” Type</th>
<th>1/3” Type</th>
<th>1/2” Type</th>
<th>2/3” Type</th>
<th>1” Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lens/Aperture Opening (LAO)</td>
<td>6.2mm</td>
<td>8.3 mm</td>
<td>12.5mm</td>
<td>16.6mm</td>
<td>25mm</td>
</tr>
</tbody>
</table>

### 3.1.5 Width of Images Sensitive Area:

The width of image sensitive area can be calculated using equation (4):

\[ D = W_d \left( \frac{f}{w_i} \right) \quad (4) \]

**Where:**

- **D:** distance from the camera (m)
- **W_d:** is width of field of view (m)
- **f:** is focal length of lens (mm)
- **w_i:** is width of images sensitive area (mm)

### 3.2 Reduced Image Scale on Monitors:

When the camera picks up a subject, the range of the coverage area varies depending on the lens selected. This is also true for the monitor and the size of the subject that can be viewed on the screen will differ depending on the size of the monitor according to table (4).

**Table (4): Monitor screen sizes.**

<table>
<thead>
<tr>
<th>fd</th>
<th>Dimensions</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Height (cm)</td>
</tr>
<tr>
<td>9-inch type</td>
<td>12</td>
</tr>
<tr>
<td>14-inch type</td>
<td>21</td>
</tr>
<tr>
<td>17-inch type</td>
<td>26</td>
</tr>
<tr>
<td>20-inch type</td>
<td>29</td>
</tr>
<tr>
<td>21-inch type</td>
<td>32</td>
</tr>
<tr>
<td>29-inch type</td>
<td>40</td>
</tr>
</tbody>
</table>

The actual size of a subject that can be displayed on a given screen can be calculated using the following formulas shows in figure (4).
Fig. (4): Reduced image scale on monitors.

The actual size of a subject that can be displayed on a given screen can be calculated using the following formulas.

\[
W_{mo} = \frac{f \times W_m \times W_{co}}{A \times L \times 0.9} \quad (5)
\]

**\(W_{mo}\): On-Screen Image Width (cm)**

**\(f\): Lens Focal Length (mm)**

**\(W_m\): Monitor Screen Width (cm)**

**\(W_{co}\): On Screen Subject Width (cm)**

**\(L\): Distance between camera and subject (cm)**

**\(A\): Width Constant of CCD Size**

**\(0.9\): Over Scan of Monitor (cm)**

**\(H_{mo} = \frac{f \times H_m \times H_{co}}{B \times L \times 0.9} \quad (6)\)**

**\(H_{mo}\): On-screen image height (cm)**

**\(H_{co}\): On Screen Subject height (cm)**

**\(H_m\): Monitor screen height (cm)**

**\(B\): Height Constant of CCD Size**

**Table (5): Overscan of monitor distances.**

<table>
<thead>
<tr>
<th>Monitor Size</th>
<th>Distance A, m (Ft.)</th>
<th>Distance B, m (Ft.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>9-inch type</td>
<td>0.9 (3.0)</td>
<td>2.1 (6.9)</td>
</tr>
<tr>
<td>14-inch type</td>
<td>1.0 (3.3)</td>
<td>3.3 (10.8)</td>
</tr>
<tr>
<td>21-inch type</td>
<td>1.2 (3.9)</td>
<td>5.0 (16.4)</td>
</tr>
<tr>
<td>29-inch type</td>
<td>1.7 (5.6)</td>
<td>6.0 (19.7)</td>
</tr>
</tbody>
</table>

4. Hypothetical Nuclear Research Center (HNRC) as a Case Study:

A nuclear site contains many buildings: Research Reactor (RR), Nuclear Fuel Unit (NFU), and Main Guard (MG). The site has one Main Entrance (ME). The distance between the MG building and the RR is 100 meters. Nuclear complex location is surrounded by an external double peripheral fence. The double fence is the first barrier for unauthorized access of people to atomic center. The distance inside the double fences is called the isolation zone and it is a 10 meter wide distance. The fence longitudinal sides are 300 meters and is divided into three zones each zone 100 meters. The other two sides are 200 meters each, and divided into two zones, 100 meters each. Figure (5) shows site general view [9]
4.1 Research Reactor (RR) Facility:
RR is a multipurpose research reactor. It has many peaceful uses in our life. The RR is open pool type, 10 MW power, light water cooled. The reactor building is composed of two floors. A top view of the floor architecture structure is shown in figure (6).

4.1.1 Internal Areas and Zones Dimension (W×L):
The RR building floor contains four inner zones (Z01, Z02, Z07, and Z12); three locations inside reactor rooms (R1, R2, R3) and reactor hall area. Figure (6) shows RR floor and its internal zones and rooms. It has the following dimensions:
Zones; Z01, Z02, Z07 = 3 (width) × 10 (length) meters, Reactor hall area = 15 × 25 meters
Room2 (R2) = 4 × 8 meters, Room3 (R3) = 4 × 5 meters, Room1 (R1) = 4 × 15 meters,
Zone12 (Z12) = 4 × 5 meters, Zone15 (Z15) = 3 × 6 meters.

Fig. (6): Hypothetical nuclear site general view.
Fig. (6): Research reactor floor architecture structure.
4.2 Nuclear Site Closed Circuit Television System:
The closed circuit television system for HNRC-Site is divided into Exterior and Interior television system, and should contain fixed and moving cameras located according to the surface areas dimensions should be covered. External television system: should include moving cameras installed over double fence areas, in addition to fixed cameras inside the isolation zone (figure 5). Cameras numbers and location should be determined mathematically by using last formulae. Internal television system: should contain fixed cameras installed inside the RR inner zones, rooms and areas (figure 6).

4.3 Camera Parameters Calculation Methods:
Camera parameters and important factors can be determined by using the following methods:
1. A Mathematical method: by using the previous formulas mentioned in before, or by
2. A Cameras Parameter’s Calculation Program (CPCP); created and new method.

4.3.1 Cameras Parameter’s Calculation Program (CPCP):
CPCP is new software[Appendix]; created to collect cameras mathematical formulae and convert it to a simple method used as a computer program. CPCP is a simple method that makes the user selects the suitable cameras for suitable areas. By applying CPCP the user can easily determine cameras parameters, lenses and monitors dimension. CPCP includes internal library inside its Data-Base, permits the user to select monitor screen types, CCD-Formats, and lens types and inches. The program accepts any input data from the user, and determines the camera parameters which are required[8].

5. Applying CPCP and Output Results:
Before running the CPCP program, input data should be determined and delivered to the program. Some input data; the user select them from the internal library of CPCP. Other data is delivered to CPCP according to the user choice such as CCD-Format, Longest distance between the object and camera, Monitor screen size, and the nuclear site external and internal zones’ dimensions. The output results obtained from CPCP are lenses focal lens, angel of view, f-stop number, on screen image dimensions, and height of subject, and image sensitive areas; figure (7) illustrates the display screen of CPCP.

5.1 Exterior Cameras Parameters Output Results
According to the perimeter fence dimensions and its divided zones, the wide image area is 10 meters (Distance between the two double fences). The CPCP delivered input longest distance data between the object and camera is 100 meters; this number is delivered as input data to the CPCP program as (D); Distance from the camera (m)) and 1/3inch camera format. The selected model is VC2130-24 from VICON type or equivalent, Monitor screen size 17 inch, 4mm CCD-Format, are program input data

![Fig. (7): Display Screen of CPCP.](image-url)
The CPCP program output result shows that; the obtained height is $H = 7.2$ m related to $W = 10$ m, and image area dimension will be $(W \times H) = 10 \text{ (width)} \times 7.2 \text{ (height)}$. Camera parameters output results obtained from the CPCP program is shown in table (6).

**Table (6): External camera parameter CPCP program output results.**

<table>
<thead>
<tr>
<th>Item</th>
<th>Area</th>
<th>Lens format</th>
<th>Lens focal length (mm)</th>
<th>F-Stop Number</th>
<th>Height (H) meter</th>
<th>Width (W) meter</th>
<th>images sensitive area (w)</th>
<th>Angles of view (θ)</th>
<th>Number of cameras</th>
</tr>
</thead>
<tbody>
<tr>
<td>Isolation Zone</td>
<td>2/3'' Inch (LAO is) 16mm</td>
<td>8mm</td>
<td>0.5 mm ratio is 8mm/16mm</td>
<td>7.2m</td>
<td>10m</td>
<td>80mm</td>
<td>90</td>
<td>13</td>
<td></td>
</tr>
</tbody>
</table>

5.1.1 External Cameras Number and Location

Two moving pan-tilt zoom cameras should be located at each corners of perimeter fence side to cover 200 meter, two fixed cameras should be located on the middle distance, to cover the remained areas. Pan-tilt-zoom cameras are placed on corners of the perimeter fence and others significant points of the HNRC area. All cameras are linked to a central CCTV programmable matrix the distributions of the cameras as follows;

- **Eight fixed cameras:** two cameras per side (2x4 sides) should be located at the middle distance of the perimeter fence on the isolation zone and their view is in opposite directions to make interference on image viewer area and protect itself.

- **Five moving cameras:** Four moving cameras should be located at the corners of each side. One pan-tilt zoom moving cameras located on the guard building; this means; Total **13 camera units** should be used to cover 1000 meters perimeter's areas (See figure 5).

5.2 Interior Cameras Parameters Output Results

The interior CCTV system provides the necessary means to conduct alarm verification and general video monitoring inside the research reactor building. It consists on general application fixed cameras placed in the interior and also in relevant exterior locations of the buildings. Cameras location is selected from a security or operational point of view.

Fixed cameras of 1/3'' inch format are delivered to the program. The selected model is VC2130-24 from VICON type or any equivalent. The lens size is chosen according to supervision area of each one of the cameras. The inner zones, areas, and rooms’ dimensions, distance from the camera and object, Monitor screen size 17 inch, 4mm CCD-Format, are CPCP program input data. All interior cameras parameters output results are shown in table (4)

**Table (4): Interior Camera Parameter CPCP program output results**

<table>
<thead>
<tr>
<th>Item</th>
<th>Area</th>
<th>Lens format</th>
<th>Lens focal length (mm)</th>
<th>F-stop number</th>
<th>Height H meter</th>
<th>images sensitive area (w)</th>
<th>Angles of view (θ)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Zones 01, 02, 07</td>
<td>1/3'' Inch (LAO is) 8.3mm</td>
<td>16</td>
<td>1.9</td>
<td>2.25</td>
<td>4.8</td>
<td>8.2</td>
<td></td>
</tr>
<tr>
<td>Z12, Rooms (1, 2, 3)</td>
<td>10</td>
<td>2.8</td>
<td>5</td>
<td>25.9</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reactor hall area</td>
<td>8</td>
<td>0.9</td>
<td>11.25</td>
<td>4.8</td>
<td>32</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
5.2.1 Lens Focal Length (f) and Subject Dimensions:
Lens focal lengths (f mm) and Height of the subject (H) of the fixed cameras can be obtained from the CPCP program by using 1/3” inch format type:

- f=16mm  
  H=2.25 meters  
  for Zones 01, 02, 07
- f=9.6mm ~ f=10mm  
  H=2.8 meter  
  for Z12, Rooms
- f=8mm  
  H=11.25 meters  
  for Reactor hall area

Note that Z12 near to the area of the inner rooms so that the cameras specifications for the inner rooms will be chooses for Z12.

The image areas (W×H) are:

- 3 width ×2.25 height
- 4 width ×2.8 height
- 15 width ×11.25 height

5.2.2 F-Stop Number:
As mentioned above f-stop is ratio between lens focal length (f mm) and aperture opening if use 1/3 inch format so that according table (3) Aperture opening (LOA) is 8.3 so that:

- F-stop =1.9  
  for Zones 01, 02, 07
- F-stop =1.2  
  for Z12, Rooms 1,2, 3
- F-stop =0.9  
  for Reactor hall area

5.2.3 Width of Images Sensitive Area:
The width of image sensitive area can be obtained from the program as follows;

- w=4.8 for Zones 01, 02, 07
- w=5 for Z12, Rooms
- w=4.8 for Reactor hall area

5.2.4 Angles of View Calculation:
The angle of view can be obtained by delivering program inputs as:
lens focal length 16mm, 10mm, 8mm and effective dimension of CCD 2.3mm (selected technical specification of model VC2130-24 from VICON) the angle of view output results are:

- θ=8.2 for Zones 01, 02, 07
- θ=25.9 for Zone12, and Rooms
- θ=32 for Reactor hall area

5.3 External Cameras Number and Location:
Thirteen fixed cameras per floor should be used to cover the internal areas of the RR building. Camera numbers, location and Lens focal length (f) as follows:

- 4 cameras units located inside the reactor hall (f=8mm)
- 4 cameras units located inside the 3 inner rooms R1,R2,R3 (f=10mm)
- 5 cameras units should be installed at the inner zones 01, 02, 07, 12, 15 (f=16mm)

CONCLUSION
The Access Control system restricts / controls movement of people. The role of alarms and fence detection systems is to detect movement. The CCTV system provides ‘eyes’ to the security system. The CCTV system has two purposes. The first is to determine the cause of a sensor alarm. This includes determining whether the alarm is a true or false alarm. The second purpose is to provide information about an intrusion. Cameras are the starting point of the video signal and are therefore a critical component of a CCTV system. Many cameras' parameters, which are considered important factors, in designing CCTV system, should be determined and computed for selecting a suitable camera for a suitable area. These parameters, determined according to areas dimension, locations, lighting, surrounding environment, cost and user requirements. The parameters such as Lens Focal Length Angle of View, F-Stop Number and Width of Images Sensitive Area should be determined. Cameras Parameter’s Calculation Program (CPCP) is introduced as a simple and new method for calculating cameras’ parameters. Width of images sensitive area and lens focal length and different angels of view for the cameras can be determined by a CPCP.
REFERENCES


(3) Closed Circuit Television Systems Fundamentals Course"TOA Electronics, Inc. (USA), 2005.


APPENDIX
Camera Parameters Calculations Program (CPCP)

Procedure Find (Prop2$, Prop1$: A, B, Wm, Hm, Diagonal, LAO)

If (Prop2$ = '1/4 inch') Then
A := 3.2
B := 2.4
Diagonal := 4
LAO := 6.2

If (Prop2$ = '1/3 inch') Then
A := 4.8
B := 3.6
Diagonal := 6
LAO := 8.3

If (Prop2$ = '1/2 inch') Then
A := 6.4
B := 4.8
Diagonal := 8
LAO := 12.5

If (Prop2$ = '2/3 inch') Then
A := 8.8
B := 6.6
Diagonal := 11
LAO := 16.6
If ( Prop2$ = '1 inch' ) Then
A := 9.5
B := 12.7
Diagonal := 15.9
LAO := 25

If ( Prop1$ = '21–inch type' ) Then
Hm := 32
Wm := 42

If ( Prop1$ = '14–inch type' ) Then
Hm := 21
Wm := 28

If ( Prop1$ = '17–inch type' ) Then
Hm := 26
Wm := 34

If ( Prop1$ = '9–inch type' ) Then
Hm := 12
Wm := 16

If ( Prop1$ = '20–inch type' ) Then
Hm := 29
Wm := 39

******************************************************************************
******************************************************************************
******************************************************************************
End Find

Call Find (Prop2$, Prop1$ : A, B, Wm, Hm, Diagonal, LAO)

W = \frac{A}{f \cdot L}

H = \frac{B}{f \cdot L}

Wmo = \frac{f \cdot Wm \cdot Wco}{A \cdot L \cdot 0.9}

Hmo = \frac{f \cdot Hm \cdot Hco}{B \cdot L \cdot 0.9}

D = Wd \cdot \frac{f}{Wi}

\frac{i}{2 \cdot f} = \tan \left[ \frac{2}{f} \right]

F_s = \frac{f}{LAO}

If (Prop1$ = '29-inch type') Then

Hm := 40

Wm := 54

******************************************************************************
******************************************************************************
******************************************************************************