Provide Scene Video Functional Decomposition

1. Introduction

1.1. Purpose

This document delivers the functional decomposition of the R.A.C.E.S. "Provide Scene Video" (PSV) project, along with deployment of the requirements to the functions.

During Explore, alternative concepts for each of the functions will be evaluated. Ultimately, a set of complementary concepts will be selected for further deployment to design.

1.2. Organization

The document initially lists the requirements discovered during Measure. Each requirement consists of a requirement number, requirement short text, and a requirements statement. The short text is used on a number of documents to provide a more reader friendly reference than the number. The requirement statement is typically a single sentence. This is followed by a discussion of the rationale behind the requirement.

Each requirement is associated with a category which was assigned during Measure. In addition, most requirements have underlying reference documents from which they were derived.

Next the functional breakdown diagram is shown, followed by descriptions of each of the functions. Each function description includes references to related requirements.

During design, it is likely that many of these lowest level functions will need to be further decomposed. However, for synthesis of the high level concepts, the current level of detail should be adequate.

Finally, the measures are shown with their relationships to requirements.

1.3. Reference Documents

Throughout this document, references are made to various reference documents. These documents were collected during the VOC activities. The references mentioned here refer to certain marked statements in the customer voice tables collected during Measure.

References to documents		
Reference	**Document**	**Location**
C01 through C12	VOC Collection - Commanders.xls	Measure Repository
E03 through E10	VOC Collection - ES Director.xls	Measure Repository
J03	VOC Collection - KC8TLJ.xls	Measure Repository
R02 through R10	VOC Collection - RACES.xls	Measure Repository

2. Requirements

2.1. Customer Requirement 01 Alternate name Video to CV.

Shall deliver video to command vehicle from scenes remote from CV.

The project shall deliver video images from the scene of an incident, which may be hostile for any of a number of reasons, back to the emergency command vehicle (CV). This requirement is associated with:

- Category: Objective
- Reference Document: E02

2.2. Customer Requirement 02 Alternate name Keep ICs Together.

Shall permit Incident Commanders to remain colocated.

The intent of having video is to enable the incident commanders to remain colocated in order that they may work as a team. This requirement is associated with:

- Category: Objective
- Reference Document: E01

2.3. Customer Requirement 03 Alternate name Close view.

Shall be able to view items as small as 10 cm. across.

Incidents sometimes involve pressurized vessels or vehicles and examining a gage becomes a key need. Thus, the product must deliver a clear view of a small area, implying that the camera will be close to the subject. This requirement is associated with:

- Category: Camera
- Reference Document: E03

2.4. Customer Requirement 04 Alternate name Wide view.

Shall be able to view items as large as 100 meters across.

At times the incident to be monitored can involve quite a large area, for example a crowd in front of a building. Thus, a sweeping view is needed. This requirement is associated with:

- Category: Camera
- Reference Document: R04

2.5. Customer Requirement 05 Alternate name Once per month.

Shall be designed for use 12 times per year.

The system must be capable of being deployed fairly frequently, however it must be able to be deployed after some considerable storage. This requirement is intended to capture that range of readiness required. This requirement is associated with:

- Category: Other
- Reference Document: E08

2.6. Customer Requirement 06 Alternate name 1.5 Km from CV.

Shall deliver video from scenes as far as 1.5 km from the CV.

Often it is necessary to keep the command vehicle some distance from the incident, typically for safety reasons. The value of remote video comes from these situations where the incident commanders cannot simply look out the window to view the incident. This requirement is associated with:

- Category: Transmitter
- Reference Document: E09
- Reference Document: R03

2.7. Customer Requirement 07 Alternate name Husband Frequencies.

Shall consider later needs for frequencies.

Greater distances are easier to achieve at lower frequencies. However, there are limited frequencies available for video. To avoid interference from multiple transmitters, it is likely that control transmissions will need to use a frequency distant from the video frequency. Possible future implementations are likely to require greater distances, rather than shorter, so these lower video frequencies should be reserved for later use to the extent possible. This requirement is associated with:

- Category: Other
- Reference Document: R10

2.8. Customer Requirement 08 Alternate name Single person.

Shall be appropriate for placement by a single trained individual.

The video equipment will be stored in the CV for deployment at an incident. Since conditions will sometimes be hostile, an appropriately trained individual will be required to enter the problem area. Typically, only one such individual will be available. This requirement is associated with:

- Category: System
- Reference Document: E11

2.9. Customer Requirement 09 Alternate name View far away.

Shall be capable of viewing a scene as far as 500 m from the camera.

In some cases it may be difficult or undesireable to get close to the incident. For example, there may be a gunman involved or in the case of demonstrations, the appearance of officials with a camera could engender displeasure among the demonstrators. In those cases, it will be necessary to set the camera up some distance from the scene. This requirement is associated with:

- Category: Camera
- Reference Document: C01

2.10. Customer Requirement 10 Alternate name Telephoto.

Shall provide telephoto view.

Because of the distance mentioned in requirement 09, a longer focal length may be required to obtain an appropriate view. This requirement is associated with:

- Category: Camera
- Reference Document: C02

2.11. Customer Requirement 11 Alternate name 3m above ground.

Shall provide for positioning 3 meters above ground.

Because of the need to see over fences, cornfields, etc., the support for the camera must allow the camera to be positioned at least 3 meters above ground level. This requirement is associated with:

- Category: Camera
- Reference Document: C03

2.12. Customer Requirement 12 Alternate name Interference to radios.

Shall not interfere with other radios in CV.

The incident commanders require use of a number of radios in the command vehicle during an incident. It is critical that neither the incoming video nor outgoing control interfere with those communications. This requirement is associated with:

- Category: Critical
- Reference Document: C04
- Reference Document: E09

2.13. Customer Requirement 13 Alternate name Interference from radios.

Shall not be made inoperable by radios in CV.

The command vehicle contains a number of radios. The receiver and frequency selected should be immune to desense from these radios. In addition, because of the large number of radios, there is an opportunity for a large number of intermodulation products which must be avoided in frequency selection. This requirement is associated with:

- Category: Critical
- Reference Document: C04

2.14. Customer Requirement 14 Alternate name 4 hour battery.

Shall provide for operation on batteries for 4 hours.

An incident can last from an hour to several days. Approximately a four hour battery life would allow most incidents to be covered without changing batteries. The possibility of changing batteries in the field for incidents greater than four hours should be considered. This requirement is associated with:

- Category: System
- Reference Document: C05

2.15. Customer Requirement 15 Alternate name Carried by operator.

Shall be appropriate to be carried by operator.

In some incidents, it may be necessary to get a variety of views of the scene or frequently changing views. In this case, it may be more appropriate to have an operator manipulate the camera at the scene rather than control the camera remotely. This requirement is associated with:

- Category: Transmitter
- Reference Document: C06

2.16. Customer Requirement 16 Alternate name Audio.

Shall provide audio from scene.

At times it would be helpful to be able to hear what is happening at the incident. This requirement is associated with:

- Category: System
- Reference Document: C07

2.17. Customer Requirement 17 Alternate name Inside building.

Shall be capable of getting video out from a metal frame building.

Part of the reason for wanting video is that the scene may be blocked from view, for example, inside a building. Since many buildings have metal frames and/or siding, it is important to be able

to deliver the video through the building walls. This requirement is associated with:

- Category: Other
- Reference Document: C08

2.18. Customer Requirement 18 Alternate name Beyond LOS.

Shall be capable of operation when the camera is beyond line of sight.

It may be necessary to locate the CV some distance from the scene, or out of the line of sight from the scene. This may be because the area is inaccessible or it is desireable to maintain a low profile. This requirement is associated with:

- Category: Transmitter
- Reference Document: C09

2.19. Customer Requirement 19 Alternate name Private.

Video shall not be publicly available.

In many cases it is desireable that the video from the scene be unavailable to media who may rebroadcast it making it available to those involved in the incident. This requirement is associated with:

- Category: Other
- Reference Document: C10

2.20. Customer Requirement 20 Alternate name Multiple Cameras.

Shall provide multiple cameras.

In some cases, it may be desireable to have multiple views of a scene, making the potential for multiple cameras desireable. In addition, the availability of multiple cameras increases redundancy, and thus the potential reliability. This requirement is associated with:

- Category: Camera
- Reference Document: C11
- Reference Document: R04

2.21. Customer Requirement 21 Alternate name Cable.

Shall provide for cable fallback in case RF fails.

In cases where there are obstructions, interference, or poor propagation, it may be desireable to provide for cable video feed. This requirement is associated with:

- Category: Transmitter
- Reference Document: C12

2.22. Customer Requirement 22 Alternate name Remote Pan.

Shall provide remote pan.

This requirement is associated with:

- Category: Remote
- Reference Document: J03

2.23. Customer Requirement 23 Alternate name Remote Tilt.

Shall provide remote tilt.

This requirement is associated with:

- Category: Remote
- Reference Document: J03

2.24. Customer Requirement 24 Alternate name Remote Zoom.

Shall provide remote zoom.

This requirement is associated with:

- Category: Remote
- Reference Document: J03

2.25. Customer Requirement 25 Alternate name Lightweight.

Shall be lightweight.

The camera assembly will most likely be deployed by a single individual who may need to negotiate terrain while carrying the assembly. Alternatively, an operator may be expected to move around while photographing the scene. The camera assembly must be light enough to be easily carried by a single individual who may also be encumbered by HazMat gear. This requirement is associated with:

- Category: System
- Reference Document: R02
- Reference Document: R09

2.26. Customer Requirement 26 Alternate name Redundant.

Shall provide redundancy.

If some degree of redundancy is provided, this could provide the potential for quick repair in the event of a component failure. This requirement is associated with:

- Category: System
- Reference Document: R05

2.27. Customer Requirement 27 Alternate name Manual.

Shall include operating manual.

Personnel change and each event is likely to involve a different set of responders than the event before. To accomodate this need, an accurate and complete manual shall be provided which allows a responder to deploy the equipment. This requirement is associated with:

- Category: Other
- Reference Document: R06

2.28. Customer Requirement 28 Alternate name Remote position.

Shall be remotely positionable.

In the event that the incident area is hazardous, it could be advantageous to provide for remote placement or repositioning of the equipment. This requirement is associated with:

- Category: Remote
- Reference Document: R07

2.29. Customer Requirement 29 Alternate name Serviceability.

Shall provide for 24 hour service.

Incidents cannot be predicted, and the equipment should not be limited to hours of operation. This requirement is associated with:

- Category: System
- Reference Document: R08

2.30. Customer Requirement 30 Alternate name Bad Weather.

Shall provide for operation in inclement weather.

The camera and remote equipment shall be housed in such a way as to permit operation in the kinds of weather anticipated in the county (e.g. rain, snow, sleet, heat). This requirement is associated with:

- Category: Camera
- Reference Document: R11

2.31. Customer Requirement 31 Alternate name Communicate w/ Oper.

Shall provide communication to camera operator.

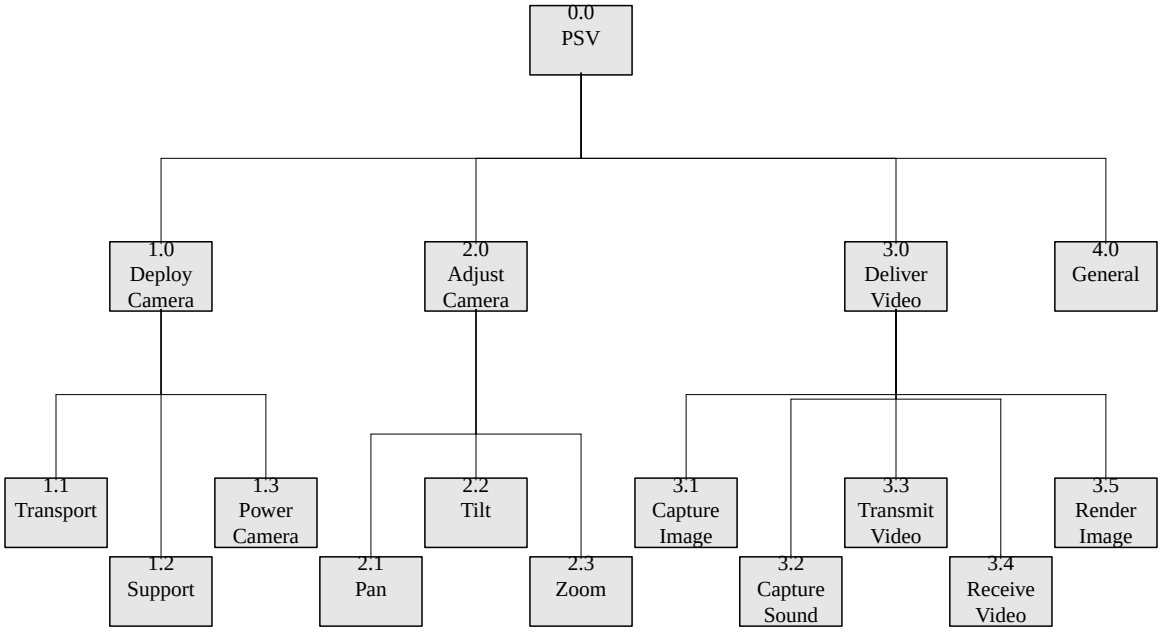
Especially in the case where the camera is to be carried around the incident scene, communications with the operator is important. This requirement is associated with:

- Category: Other

3. Structure Chart Functional Decomp 0.0

Top-level PSV Decomposition

This diagram shows the top levels of the functions required for the Provide Scene Video project. The camera must be positioned in the field with the necessary support, it must be adjusted from the command location, and it must deliver video back to the command vehicle.



3.1. Functions

3.1.1. Function 0.0 - PSV

The overarching function to be implemented is delivering video from an incident scene to the command vehicle. This top level function is implemented through a number of lower level functions. This element of the model is related to satisfying the following requirements:

- Customer Requirement 01
- Customer Requirement 02

3.1.2. Function 1.0 - Deploy Camera

It is necessary that the camera be placed at the scene, which is expected to be remote from the command vehicle. The camera not only must be transported, but it must be somehow be supported, both physically and with power.

3.1.3. Function 1.1 - Transport

The camera and supporting equipment must be positioned at the scene. The camera may be placed by an operator, or could position itself. This element of the model is related to satisfying the following requirements:

- Customer Requirement 06
- Customer Requirement 08

- Customer Requirement 15
- Customer Requirement 25
- Customer Requirement 28
- Customer Requirement 31

3.1.4. Function 1.2 - Support

The camera must be able to view the scene. To do this it will need to be supported by some sort of stand or tripod, or be carried and aimed by an operator. This element of the model is related to satisfying the following requirements:

- Customer Requirement 11

3.1.5. Function 1.3 - Power Camera

The camera requires power in the field, either from batteries or some other source. This element of the model is related to satisfying the following requirements:

- Customer Requirement 14

3.1.6. Function 2.0 - Adjust Camera

Once it has been placed in the field, the camera may require adjustment from time to time.

3.1.7. Function 2.1 - Pan

It must be possible to direct the camera to view left and right. This element of the model is related to satisfying the following requirements:

- Customer Requirement 22

3.1.8. Function 2.2 - Tilt

It must be possible to direct the camera to point up or down. This element of the model is related to satisfying the following requirements:

- Customer Requirement 23

3.1.9. Function 2.3 - Zoom

It must be possible to direct the camera to alter its focal length. This element of the model is related to satisfying the following requirements:

- Customer Requirement 24

3.1.10. Function 3.0 - Deliver Video

Imagery from the incident scene must be delivered to the Incident Commanders located in the command vehicle.

3.1.11. Function 3.1 - Capture Image

Imagery from the incident must be captured, presumably from somewhere close to the scene. This element of the model is related to satisfying the following requirements:

- Customer Requirement 03
- Customer Requirement 04
- Customer Requirement 07
- Customer Requirement 09
- Customer Requirement 10

- Customer Requirement 17
- Customer Requirement 20

3.1.12. **Function 3.2** - Capture Sound

Audio from the scene must be captured. This element of the model is related to satisfying the following requirements:

- Customer Requirement 16

3.1.13. **Function 3.3** - Transmit Video

The video and sound from the scene must be transmitted to the command vehicle. This transmission by default will likely be over UHF radio, but in some situations it may be desireable to provide cable capability. This element of the model is related to satisfying the following requirements:

- Customer Requirement 06
- Customer Requirement 07
- Customer Requirement 12
- Customer Requirement 17
- Customer Requirement 18
- Customer Requirement 19
- Customer Requirement 21

3.1.14. **Function 3.4** - Receive Video

The transmitted video must be received in the command vehicle. Within the vehicle there is a significant possibility of significant RF levels on or near the video frequency. This element of the model is related to satisfying the following requirements:

- Customer Requirement 01
- Customer Requirement 13

3.1.15. **Function 3.5** - Render Image

After the video has been transmitted to the command vehicle, it will be necessary to render the image for viewing by the incident commanders. This element of the model is related to satisfying the following requirements:

- Customer Requirement 01
- Customer Requirement 02

3.1.16. **Function 4.0** - General

This function is not truly a function, but a placeholder to capture some general system characteristics. These requirements cross several functions. This element of the model is related to satisfying the following requirements:

- Customer Requirement 05
- Customer Requirement 26
- Customer Requirement 27
- Customer Requirement 29
- Customer Requirement 30

4. Measures

4.1. Engineering Requirement 01 Alternate name Spurs on Freq.

Frequency shall be selected for which IM products from CV radios is -40 dBm or lower.

There are a number of radios in the command vehicle with the possbility of a large number of intermodulation products. While it may be impossible to select a frequency with no IM products, frequencies should be selected which involve IM products at -40dBm or lower.

This measure is derived from:

- Customer Requirement 13
- Customer Requirement 21
- Customer Requirement 22
- Customer Requirement 23
- Customer Requirement 24

4.2. Engineering Requirement 02 Alternate name Desense to CV radios.

C.V. radios shall suffer less than 20 dB of desense. Control and video transmittters should not cause desense to radios in the command vehicle.

This measure is derived from:

- Customer Requirement 12
- Customer Requirement 31

4.3. Engineering Requirement 03 Alternate name Desense from CV Radios.

Video receiver shall suffer less than 40 dB of desense from the CV radios.

Receivers should be designed so as not to suffer desense from radios in command vehicle.

This measure is derived from:

- Customer Requirement 06
- Customer Requirement 13
- Customer Requirement 17
- Customer Requirement 18

4.4. Engineering Requirement 04 Alternate name Width of view.

Cmaera shall view a field of 45 degrees.

This measure is derived from:

- Customer Requirement 04
- Customer Requirement 24

4.5. Engineering Requirement 05 Alternate name Zoom Range.

Lens shall have at least a 4:1 zoom range.

This measure is derived from:

- Customer Requirement 04
- Customer Requirement 09
- Customer Requirement 10

4.6. Engineering Requirement 06 Alternate name Number of cameras.

At least two cameras shall be provided.

This measure is derived from:

- Customer Requirement 01
- Customer Requirement 02
- Customer Requirement 08
- Customer Requirement 12
- Customer Requirement 13
- Customer Requirement 15
- Customer Requirement 20
- Customer Requirement 26
- Customer Requirement 29

4.7. Engineering Requirement 07 Alternate name Min op temp.

System shall be capable of being operated at temperatures as low as -10 degrees C.

This measure is derived from:

- Customer Requirement 29
- Customer Requirement 30

4.8. Engineering Requirement 08 Alternate name Max op temp.

System shall be capable of operating at an ambient temperature of 40 deg. C.

This measure is derived from:

- Customer Requirement 29
- Customer Requirement 30

4.9. Engineering Requirement 09 Alternate name Max op dewpoint.

System shall be capable of operating when the dewpoint is 30 deg. C.

This measure is derived from:

- Customer Requirement 29
- Customer Requirement 30

4.10. Engineering Requirement 10 Alternate name Lens height AG.

System shall be capable of supporting the lens at least 3 meters above grade.

This measure is derived from:

- Customer Requirement 03
- Customer Requirement 04
- Customer Requirement 09
- Customer Requirement 10
- Customer Requirement 11

4.11. Engineering Requirement 11 Alternate name Max distance from CV.

System shall be able to support a camera location at least 1.5 km from the CV.

This measure is derived from:

- Customer Requirement 01
- Customer Requirement 02
- Customer Requirement 06

4.12. Engineering Requirement 12 Alternate name Weight camera ass'y.

The camera assembly shall weigh less than 10 kg.

This measure is derived from:

- Customer Requirement 08
- Customer Requirement 15
- Customer Requirement 25

4.13. Engineering Requirement 13 Alternate name Size camera ass'y.

The camera assembly shall occupy less than one cubic meter.

This measure is derived from:

- Customer Requirement 08
- Customer Requirement 15
- Customer Requirement 25

4.14. Engineering Requirement 14 Alternate name # Pieces camera ass'y.

The camera assembly shall be transported as a single piece.

This measure is derived from:

- Customer Requirement 08
- Customer Requirement 15
- Customer Requirement 25

4.15. Engineering Requirement 15 Alternate name Operation around obstructions.

Still need a measure for this one.

This measure is derived from:

- Customer Requirement 08
- Customer Requirement 17
- Customer Requirement 18

4.16. Engineering Requirement 16 Alternate name Cable Capability.

Shall be capable of using cable as a backup for RF.

This measure is derived from:

- Customer Requirement 02
- Customer Requirement 07
- Customer Requirement 08
- Customer Requirement 12
- Customer Requirement 21

4.17. Engineering Requirement 17 Alternate name Remote pan.

Shall allow for remote pan.

This measure is derived from:

- Customer Requirement 02
- Customer Requirement 22

4.18. Engineering Requirement 18 Alternate name Remote pan angle.

Shall permit panning over 180 degrees.

This measure is derived from:

- Customer Requirement 02
- Customer Requirement 22

4.19. Engineering Requirement 19 Alternate name Remote tilt.

Shall allow for remote tilt.

This measure is derived from:

- Customer Requirement 02
- Customer Requirement 23

4.20. Engineering Requirement 20 Alternate name Remote tilt angle.

Shall permit remotely tilting the camera over a range of 45 degrees.

This measure is derived from:

- Customer Requirement 02
- Customer Requirement 23

4.21. Engineering Requirement 21 Alternate name Compatible remote zoom.

Shall provide for remotely controlling lens focal length from the command vehicle.

This measure is derived from:

- Customer Requirement 02
- Customer Requirement 24

4.22. Engineering Requirement 22 Alternate name Remote positioning.

Shall permit camera position to be adjusted remotely.

This measure is derived from:

- Customer Requirement 02
- Customer Requirement 28

4.23. Engineering Requirement 23 Alternate name Time for setup.

Shall be capable of being set up in the field in 10 minutes or less.

During an incident, especially in the first few minutes, there are typically insuffucient responders available. A complex and time consuming setup process will be a deterrent to use.

This measure is derived from:

- Customer Requirement 08
- Customer Requirement 15

4.24. Engineering Requirement 24 Alternate name Complexity of setup.

Need a metric for this one.

This measure is derived from:

- Customer Requirement 05
- Customer Requirement 08
- Customer Requirement 29

4.25. Engineering Requirement 25 Alternate name Life of battery.

Battery shall last for at least four hours.

This measure is derived from:

- Customer Requirement 14

4.26. Engineering Requirement 26 Alternate name Audio from field.

Shall provice for audio from field.

This measure is derived from:

- Customer Requirement 02
- Customer Requirement 13
- Customer Requirement 16
- Customer Requirement 31

4.27. Engineering Requirement 27 Alternate name Number useable configs.

Shall provide for at least 4 different useable configurations.

This measure is derived from:

- Customer Requirement 02
- Customer Requirement 26
- Customer Requirement 29

4.28. Engineering Requirement 28 Alternate name Mean TTR.

Shall be repairable in a mean time of 24 hours.

This measure is derived from:

- Customer Requirement 29

4.29. Engineering Requirement 29 Alternate name # frequencies required.

Shall require fewer than three frequencies.

This measure is derived from:

- Customer Requirement 07
- Customer Requirement 12
- Customer Requirement 13

4.30. Engineering Requirement 30 Alternate name Lowest freq required.

Operation should be confined to frequencies above 900 MHz.

This measure is derived from:

- Customer Requirement 09
- Customer Requirement 12
- Customer Requirement 13
- Customer Requirement 19

4.31. Engineering Requirement 31 Alternate name Manual.

Shall provide an operator manual.

This measure is derived from:

- Customer Requirement 05
- Customer Requirement 27

4.32. Engineering Requirement 32 Alternate name Communication with operator.

Shall provide for communication with operator.

This measure is derived from:

- Customer Requirement 12
- Customer Requirement 13
- Customer Requirement 31

4.33. Engineering Requirement 33 Alternate name ERP.

Shall deliver an effective radiated power of 10 watts.

This measure is derived from:

- Customer Requirement 06
- Customer Requirement 12
- Customer Requirement 17
- Customer Requirement 18

4.34. Engineering Requirement 34 Alternate name Video frequency.

Video shall be transmitted in the 2.4 GHz band. Lower frequencies should be reserved for applications requiring greater distance. In addition, lower frequency video is easier to intercept. Transmission at frequencies of 2.4 GHz or higher should provide reasonable equipment availability while keeping lower frequencies available for other purposes.

This measure is derived from:

- Customer Requirement 07
- Customer Requirement 12
- Customer Requirement 13
- Customer Requirement 19

4.35. Engineering Requirement 35 Alternate name Battery memory.

Battery memory characteristics should be no poorer than sealed lead acid batteries.

Because the equipment will be operated intermittently, battery memory characterstics similar to Nickel-Cadmium batteries could be a problem. Although SLA batteries are not a requirement, the memory characteristics of SLA batteries are appropriate for this application.

This measure is derived from:

- Customer Requirement 05

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