

## Functional specification and Risk Assessment

### Wallcomm (Biza Khuluma) Intercom System



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## **1. SCOPE**

### **1.1 Purpose**

This specification establishes the performance, design, test, manufacture, and acceptance characteristics and requirements for the Wallcomm (Biza Khuluma) intercom system.

### **1.2 Identification**

This document is comprised of the following sections:

1. Section 2: Product definition
2. Section 3: Quality assurance provisions
3. Section 4: Configuration control

## **2. PRODUCT DEFINITION**

### **2.1 Product definition**

The Wallcomm (Biza Khuluma) intercom system is used for communication between different areas in a mine or factory. The unit operates as a Push-to-Talk system and multiple units can be connected on a line. The system was developed specifically for harsh conditions.

### **2.2 SYSTEM PRIMARY FUNCTIONS**

#### **2.2.1 Primary mission**

The primary mission of the system is to enhance the communication between areas.

#### **2.2.2 Secondary functions**

Apart from communication, the following functions are supported by the system:

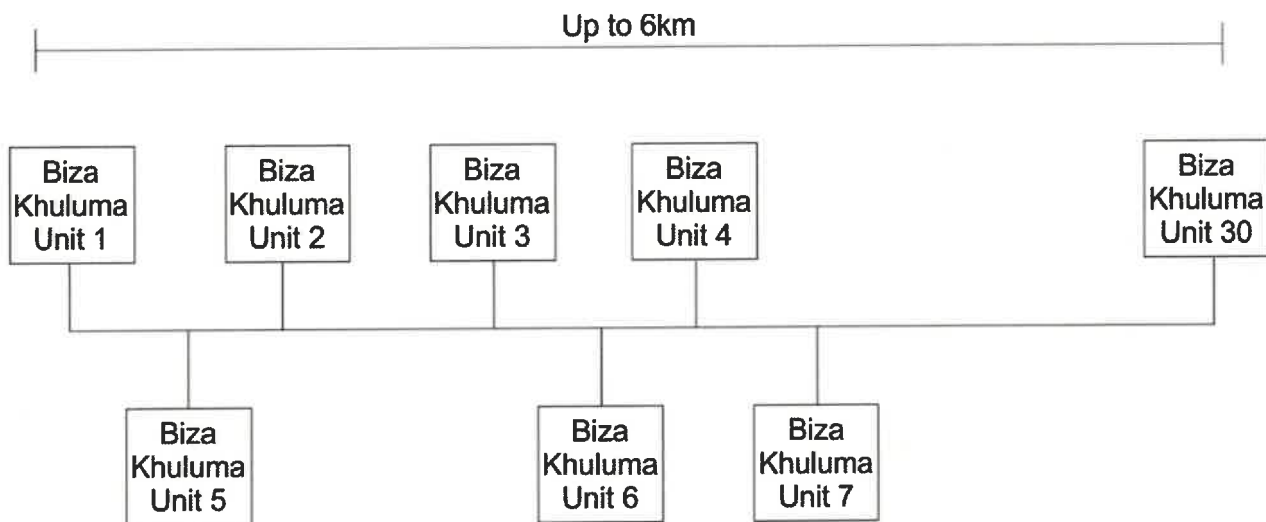
1. The Wallcomm (Biza Khuluma) intercom system consists of a battery backup unit to ensure operation when power has failed;
2. Multiple units can be interconnected to allow up to 30 units on a line with a maximum range of 6 km;
3. The Wallcomm (Biza Khuluma) intercom system is housed in a robust mild steel or stainless steel enclosure.

## 2.3 System and component arrangement diagrams

This sub-section incorporates the functional schematic and flow diagrams of the system. Layout drawings that establish the general relationship of major components are included.

### 2.3.1 System arrangement

The Wallcomm (Biza Khuluma) system can accommodate up to 30 units, all connected in parallel to form the intercom system. Each unit must be supplied with AC power (110V AC or 220V AC) individually. All the units connected on this system can communicate to one another on a push-to-talk basis. The Wallcomm (Biza Khuluma) system arrangement is shown in *Figure 1*.



**FIGURE 1- TYPICAL LAYOUT FOR THE BIZA KHULUMA INTERCOM SYSTEM**

### 2.3.2 System Components

The system consists of up to 30 Wallcomm (Biza Khuluma) units. An individual Wallcomm (Biza Khuluma) unit is described in the following sub-sections.

### 2.3.2.1 Wallcomm (Biza Khuluma) unit



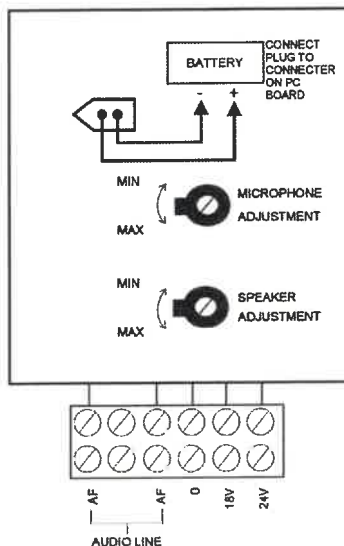
**FIGURE 2 - WALLCOMM (BIZA KHULUMA) UNIT**

Figure 2 shows a photo of a single Wallcomm (Biza Khuluma) unit. The unit consists of the following components:

1. **Speaker:** The unit uses an 8 ohm 5 Watt speaker for audio communication. The speaker is sealed with a plastic membrane to limit the ingress of dust and water;
2. **Call push-button:** This is a mechanical push button, used to send a "call" signal to all the interconnected units. This push button has an IP65 rating with approximately 10000 operation cycles;
3. **Speak push-button:** This is a mechanical push button and should be held down while talking. This will activate the microphone while all the units down the line will be able to listen. This push button has an IP65 rating with approximately 10000 operation cycles;
4. **Microphone:** A standard telephone 4T capsule is used;
5. **Torx screws:** This prevents tampering of the unit. This also limits access to the backup batteries;

6. **Connection box bolts:** These are easier to open and allow access to the connection box for installation purposes. More detail of the connection box can be found in the following figure;
7. **Connection box lid:** The lid should be removed to enable access to the connection box;
8. **Gland hole for communications cable:** This hole allows a 20mm gland to be fitted to seal off the communications cables that interconnect the Wallcomm (Biza Khuluma) units;
9. **Gland hole for power cable:** This hole is also 20mm to allow for a gland. Power {110V or 220V} should be connected through this gland;
10. **Mounting bracket:** The system can be mounted with this bracket;

### **2.3.2.2 Wallcomm (Biza Khuluma) connection box**



**FIGURE 3 - WALLCOMM (BIZA KHULUMA) CONNECTION BOX**

Figure 3 shows the connection box of a Wallcomm (Biza Khuluma) unit. This connection box is located at the bottom of the Wallcomm (Biza Khuluma) unit - the lid has been removed in the image above. The connection box should be accessed during installation and consists of the following components:

1. **Input power connector block:** The input power cable to the system should be terminated using this connector block. The connector block consists of three terminals. These terminals are as follows:  
 Left: 220V AC live  
 Middle: 110V AC live  
 Right: Neutral

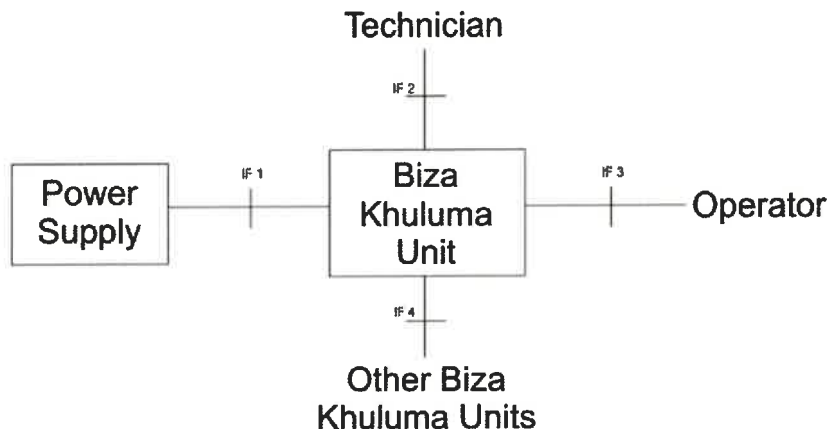
*Note: This allows for the system to be operated in by either a 220V AC or 110V AC power source.*



2. **Communications cable connector block:** This connector block should be used to terminate the communication cable of the system. A 2 core twisted pair communication cable is used. All Units should be connected in parallel and this connector block can support multiple terminations;
3. **Battery connector:** The battery connector consists of an inline male and female plug. The unit is shipped with this plug open to ensure that the unit is not operational during shipment. This connection should be made during installation in order to connect the backup batteries to the system; Battery backup is supplied to allow (if fully charged) for approximately 6 hours continuous use and 96 hours standby use of the system.

## 2.4 Interfaces

A basic interconnection diagram (see *Figure 4*) below shows the interface arrangement of a Biza Khuluma unit in the system:



**FIGURE 4 - WALLCOMM (BIZA KHULUMA) UNIT INTERFACES**

The main interfaces are shown above. These are described as follows:

1. IF 1 - An interconnecting power cable between the Wallcomm (Biza Khuluma) unit and the power source;
2. IF 2 - This is the interface between the technician and the Wallcomm (Biza Khuluma) units;
3. IF 3 - This is the communication interface between the operator and the Wallcomm (Biza Khuluma) unit;
4. IF 4 - This interface describes the communication cable interconnecting all the Wallcomm (Biza Khuluma) units in the system;

Each of these interfaces are described in the following sub-sections:

#### 2.4.1 IF 1 - Power cable

The system can operate on either 220V AC or 110V AC. This is a 2 core cable and must be terminated in the connection box of the Wallcomm (Biza Khuluma) unit according to the voltage specification.

*Note: All Wallcomm (Biza Khuluma) units in the system must be connected to a power source.*

#### 2.4.2 IF 2 - Maintenance performed by a technician

The system must be tested and maintained regularly in order to ensure proper operation. The system communication (speak and call) should be tested together with the status of the batteries. If the batteries are faulty, they should be replaced due to their limited lifetime. This should be done according to schedule - a battery's specified life time is not less than 2 years.

#### 2.4.3 IF 3 - Operator interface

Two push-buttons are used to interface with the system. The "Call" button should be pressed when the operator needs to start communication while the "Speak" button should be held down when the operator talks.

Audible communication is provided by means of a 5 Watt speaker.

#### 2.4.4 IF 4 - Communication cable

The communication cable is used for interconnection between all the Wallcomm (Biza Khuluma) units. This should be a 2-core x 1mm<sup>2</sup> twisted pair communication cable and the units are connected in parallel. The maximum distance between the units furthest apart (that is, on the ends) should not exceed 6km.

*Note: Low voltage signals (less than 18V) are routed along the communication cables in IF 4.*



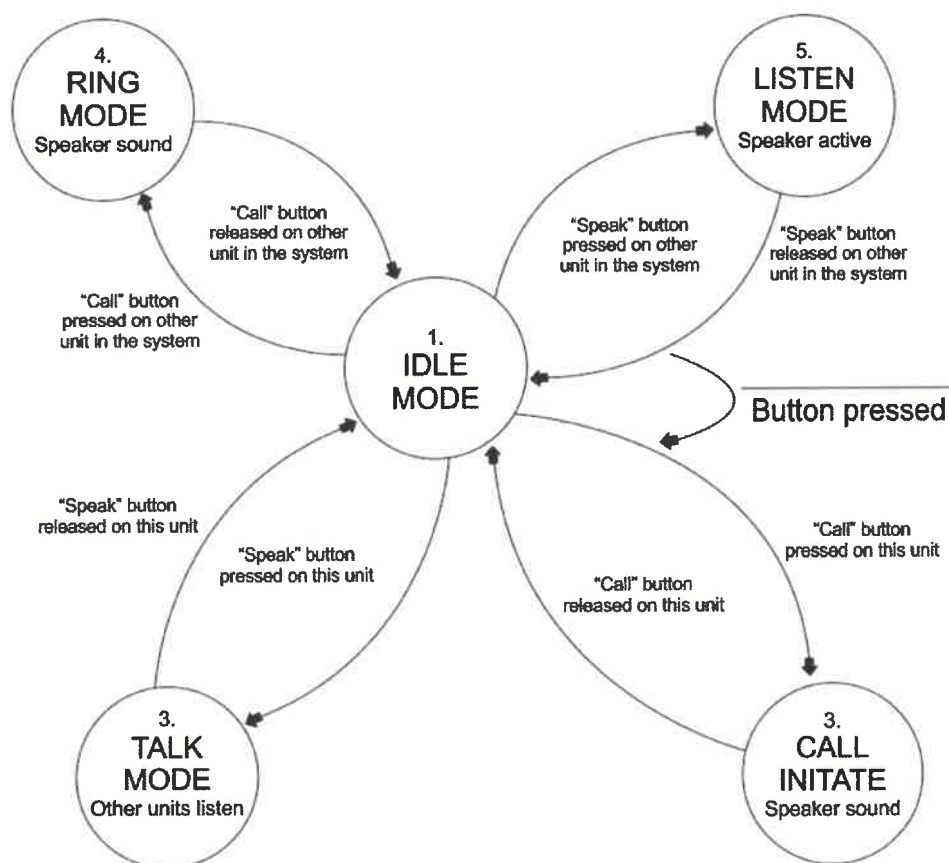
## 2.5 Characteristics

This section describes the functions of the Wallcomm (Biza Khuluma) system in terms of its operational modes. Where applicable, a function's performance, physical and/or other characteristics are given.

### 2.5.1 Functional characteristics

#### 2.5.1.1 Modes of operation

The modes of operation for the Wallcomm (Biza Khuluma) are shown in the following state diagram. This diagram shows the states of a single Wallcomm (Biza Khuluma) unit in the system:



**FIGURE 5 - WALLCOM (BIZA KHULUMA) STATE DIAGRAM**

1. **Idle mode:** This is the default mode of the system when the unit is powered up. In this mode the speaker is silent and the microphone is inactive. From this mode each of the other 4 modes can be entered;

2. Call initiate: This mode is entered when the "call" button is pressed. The speaker on all the connected units will sound (ring) for the duration of the button press. This draws the attention of the operator(s) at each station. This action should be followed with a "speak" button press for the system to enter talk mode. The conversation should then start.

*Note that the other units on the system will be in ring mode while this particular unit is in the call initiate mode.*

3. Talk mode: When the "speak" button is pressed, the operator can speak into the microphone. This will be heard on all the Wallcomm (Biza Khuluma) units connected to the system.

*Note that in this mode the other units on the system must be in listen mode. Only a single unit on the system can be in talk mode while all the other units will be in listen mode.*

4. Ring mode: In this mode the speaker of each Wallcomm (Biza Khuluma) unit will sound to initiate a ring. This draws the attention of the operators at each station to be aware of a conversation starting shortly.
5. Listen mode: -When one Wallcomm (Biza Khuluma) unit is in the talk mode all the remaining units will be in the listen mode. During this mode each station can hear what the operator says at the station in talk mode.

#### 2.5.1.2 Failure modes

Different failure modes of the system have been identified. The effect of these failure modes can also be seen in the risk analysis done in section 2.6. The failure modes are as follows:

1. External power cable fault: If the power cable is faulty, no power will be supplied to the system. The batteries will run out, after which the system will fail. This is a total module failure but the remaining units, connected to the system, will still be operational;
2. External over-voltage: If the incorrect voltage is supplied to a unit, the internal fuse will blow and needs to be replaced at the factory this fault should only occur when very high voltage surges occur;
3. External interconnection cable fault (open circuit): When the communication cables interconnecting the Wallcomm (Biza Khuluma) units are open circuit, the system will effectively be split into two separate systems with the result that the one side will not be able to communicate with the faulty side but all units will still be operational;
4. External interconnection cable fault (closed circuit): When the communication cables interconnecting the Wallcomm (Biza Khuluma) units are closed circuit, the system will effectively fail;
5. Backup power failure: NiCad (nickel-cadmium) batteries are used to supply backup power. These batteries need to be maintained and replaced when necessary. The backup battery should be replaced at least every two years, depending on the charge / discharge cycles of the system.

6. Speaker failure: When a speaker of a specific unit fails, that specific station will not be able to listen to other stations. The speaker should be tested regularly to ensure operation to the required sound levels.
7. Microphone failure: If the microphone fails, no communication can be initiated from this specific unit. The unit will still be able to listen to other conversations. Each unit should be tested regularly to ensure proper operation of the microphone.
8. Internal electronic module fault: This is a total unit failure and can only be detected by testing the module before use.
9. Incorrect installation: The system should be correctly installed in order to allow functional capability and easy (human / operator) access to the system. The system should also not be installed in noisy areas.
10. Environmental Hazard: Possible environmental factors might affect the operation of the system. Refer to the IP rating of the units.

## 2.5.2 Performance characteristics

### 2.5.2.1 Durability

Various factors influence durability, including use factors. However, components in the system were designed to provide durability in a number of ways:

1. The mechanical design was done to provide a strong robust, mild steel or stainless steel (3CR12) enclosure;
2. All enclosures comply with an IP53 specification due to the audio communication. (Dust protected and limited ingress when water is sprayed from any direction up to 60 degrees from the vertical);
3. Electronics are conformably coated to provide protection against corrosion.

### 2.5.2.2 Health and safety

Although all possible steps were taken from a design point of view to ensure safety, the following aspects are of high importance:

1. Procedures must be put in place to test for explosive gasses before any system is powered up;
2. Nickel-Cadmium batteries are used within the system. The internal components of these batteries include Nickel Ox hydroxide, Cadmium and liquid electrolyte. Nickel Cadmium batteries do not leak electrolyte under normal usage conditions, but in the case of skin exposure, the exposed skin should be washed with copious amounts of water. Note: These harmful substances internal to the batteries can be exposed during direct fire or explosion. Note that these batteries are located within the enclosure to limit possible exposure.

### 2.5.2.3 Maintainability and inter-operability

A swap-out policy was followed for unscheduled maintenance. The following specific guidelines should be followed:

1. No component should be opened for second-line repairs on the premises of the client;
2. The swap-out policy was designed into the system and facilitates a "drop-in" replacement of similar-type modules.

### 2.5.2.4 Transportability

The Wallcomm (Biza Khuluma) units will be exposed to harsh conditions and were designed with the following requirements:

1. Humans will carry the units. Therefore the enclosure is light-weight and small;
2. All units are transported in protective cardboard boxes and are protected against shock and vibration.

### 2.5.2.5 Materials processes and parts

All materials used in the design were selected to withstand harsh conditions. Enclosures are manufactured from mild steel or stainless steel and powder coated to withstand all environmental conditions common to mines;

### 2.5.2.6 Modularity

Units were designed to be modular and interchangeable in as far as possible. This is to facilitate swap out and replacement on site as well as to reduce the skills level requirements on maintenance personnel in operation.

The quantified risk analysis for the Wallcomm (Biza Khuluma) intercom system is done in the following section. The risk ratings used is defined in the following table:

Consequence Rating (CR)					
Rating	1	2	3	4	
Explanation	Near miss injury/ Damage	Disabling Injury	Serious Injury	Fatality	
Probability Rating (PR) - this is not a linear scale, please refer to the %					
Rating	1 (<1%)	2 (1%-5%)	3 (5%-10%)	4 (10%-50%)	
Explanation	Practically Impossible	Not likely to happen	Could happen	Has happened	
Risk Rating (RR) = Consequence x Probability					
0-7	8-15	16-25			
Low	Medium				



## 2.6 Wallcomm (Biza Khuluma) System Risk Matrix

The risk matrix below indicates risk identified within the system. Please note that the current risk can be significantly reduced by implementing the recommended controls as shown with the reduced risk option.

Wallcomm (Biza Khuluma) System Technical / Operational Risk									
Number	Failure Mode	Consequences	CR	PR without control	RR without control	Additional controls	CR	PR with control	RR with control
1	Power cable fault	No power to a specific unit. Unit failure. Remaining units will still be working.	3	1	3	Develop test specification to test the system regularly. Battery backup is included to keep the system operational for a certain time.	3	0.5	1.5
2	External over voltage condition	Unit failure. Remaining units will still be working.	3	2	6	Implement protection - done ....	3	1	3
3	Biza Khuluma Interconnection communication cable fault	No communication between Biza Khuluma units. System may be split in two separate systems. System Failure	4	2	8	Develop test specification to test the system regularly.	4	1	4
4	Backup battery failure	No power to a unit when main power fails. Unit failure. Remaining units will still be working.	3	1	3	Develop test specification to test the system regularly. Replace battery every 2 years.	3	0.5	1.5
5	Battery theft	No power to the system when main power fails. Unit failure. Remaining units will still be working.	3	2	6	Use tamper proof torx screws to close enclosure	3	1	3
6	Speaker failure	No signals will be heard from other units. Can still send signals (One way communication) Remaining units will still be working.	2	1	2	Develop test specification to test the system regularly	2	0.5	1
7	Microphone failure	No signals will be send to other units. Can still receive signals. (One way communication) Remaining units will still be working.	2	1	2	Develop test specification to test the system regularly	2	0.5	1
8	Biza Khuluma internal module failure	Unit Failure	3	1	3	Develop test specification to test the system regularly	3	0.5	1.5
9	Incorrect installation	Minimal to limited access to the unit. Possible installation in high noise areas.	3	2	6	Installation documentation and sufficient training	3	0.5	1.5
10	Environmental Hazard (Direct Fire)	System Failure	4	1	4	Ensure proper installation is a safe area	4	0.5	2
11	Personnel training support system failure	System Failure	4	3	12	Ensure effective training documentation is available	4	1	4
12	Maintenance and repair support system failure	System Failure	4	3	12	Schedule additional maintenance and keep stock of the system components	4	1	4

### 3 QUALITY ASSURANCE PROVISIONS

#### 3.1 Manufacturing

##### 3.1.1 Documentation

All manufacturing, assembly, and test documentation was done to control quality during manufacturing. Quality design, procurement, manufacturing and assembly, and test and inspection procedures are documented and enforced.

##### 3.1.2 Tests

The following tests are done during manufacture:

1. Component inspection before assembly;
2. Board-level testing is done to prevent infant mortality;
3. Assembly inspection is done;
4. Component-level testing is done;
5. Module-level testing is done;
6. Packaging inspection is done.

#### 3.2 Installation, operation, and maintenance

##### 3.2.1 Documentation

Installation, operational and maintenance documentation is available to ensure quality use of the system.

##### 3.2.2 Tests

The following test procedures must be followed when utilizing the system:

1. Module inspection before installation;
2. First use inspection should be done on customer premises;
3. Replacement inspection and testing.