



INTEGRATED RADIO COMMUNICATIONS FRAMEWORK FOR NEW ZEALAND LAND-BASED SEARCH AND RESCUE OPERATIONS

Prepared for the Secretariat, New Zealand Search and Rescue Council

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This report has been prepared on the basis set out in the Contract for Services with the Ministry of Transport. This report is for the benefit of the New Zealand Search and Rescue Council for use at their discretion. We have not verified the reliability or accuracy of any information obtained in the course of our work.

1 Executive Summary

1.1 Introduction

New Zealand relies on a healthy relationship between professional and volunteer organisations to provide effective search and rescue services (SAR) across the country's landmass. A common requirement of all SAR activities is access to dependable, reliable means of radio communication.

This review of radio equipment used by organisations that carry out land-based search and rescue in New Zealand confirms that 2-way High Frequency (HF) and Very High Frequency (VHF) radio are essential for SAR operations in a world that is increasingly dominated by cellular communications.

1.1.1. Terms of Reference

Terms of reference for developing the framework are contained in the New Zealand Search and Rescue Council Secretariat's "Search and Rescue Communications – Land Environment" paper.

1.1.2. Project Initiation

The SAR Council requested the SAR Secretariat to undertake a review of current radio communications capabilities and practices available to SAR organisations, and what changes are likely to occur in technologies, networks, functionality and management practices in the future.

The SAR Secretariat contracted Caravel Group (NZ) Ltd to review current and research future radio communications practices and requirements, and to recommend any changes deemed necessary to ensure SAR communications are reliable, ubiquitous, and available to support the safety and effectiveness of search teams for the success of land-based SAR operations.

1.1.3. Methodology

A framework based on achieving a goal of "affordable and sustainable radio communications that efficiently and effectively support land-based search and rescue activities while assuring the safety of SAR personnel and the public" was initially developed and subsequently refined to reflect information and advice from a number of stakeholders. This included input from a survey sent to SAR agencies and stakeholders.

Principles that underpin the framework include:

- Reliable – Reliable, replicable communications when/wherever required

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- Usable – SAR teams can set up and operate the radio equipment under any conditions
- Available – radio services can be established where required on New Zealand’s landmass
- Effective – radio equipment and services (voice, low speed data etc.) that are appropriate to the situation
- Sustainable – cost effective, environmentally and technically sound, supporting SAR health and safety policies

Framework elements

Framework elements that are influenced by the above principles include:

- Equipment
- Workforce
- Incident management
- Coordination
- Stakeholder management
- Protocols
- Environment management

The framework has been created through a combination of SAR organisation information, research and Caravel’s experience in developing and implementing similar reviews of current and future technology, and operating practices. It has been used to develop recommendations and an action plan to maintain and improve radio communications capability and usage by the SAR community.

1.2. Recommendations

This review offers recommendations for improving the availability and effectiveness of 2-way radio as a critical component of SAR activities.

The recommendations include:

1. Establish a technical working group with participants from key SAR agencies including NZ SAR, Police, LandSAR, DOC, AREC, RCCNZ, NZ Defence, Surf Lifesaving New Zealand, Coastguard, Civil Defence and Mountain Radio.
2. Ask Police to continue support (either in house or outsourced) for their analogue VHF radio equipment (handheld radios and repeaters) used for SAR.
3. Ensure the Police HF radio network capability is retained and users are trained and practiced in its deployment and use.
4. Confirm accessibility of the Police’s VHF digital trunk radio network for non-Police SAR activities.
5. Confirm accessibility to other VHF networks including DOC, Maritime, Civil Defence, AREC DMR and Surf Lifesaving NZ DMR.
6. Develop a radio asset management database to support digital trunking and GPS tracking.

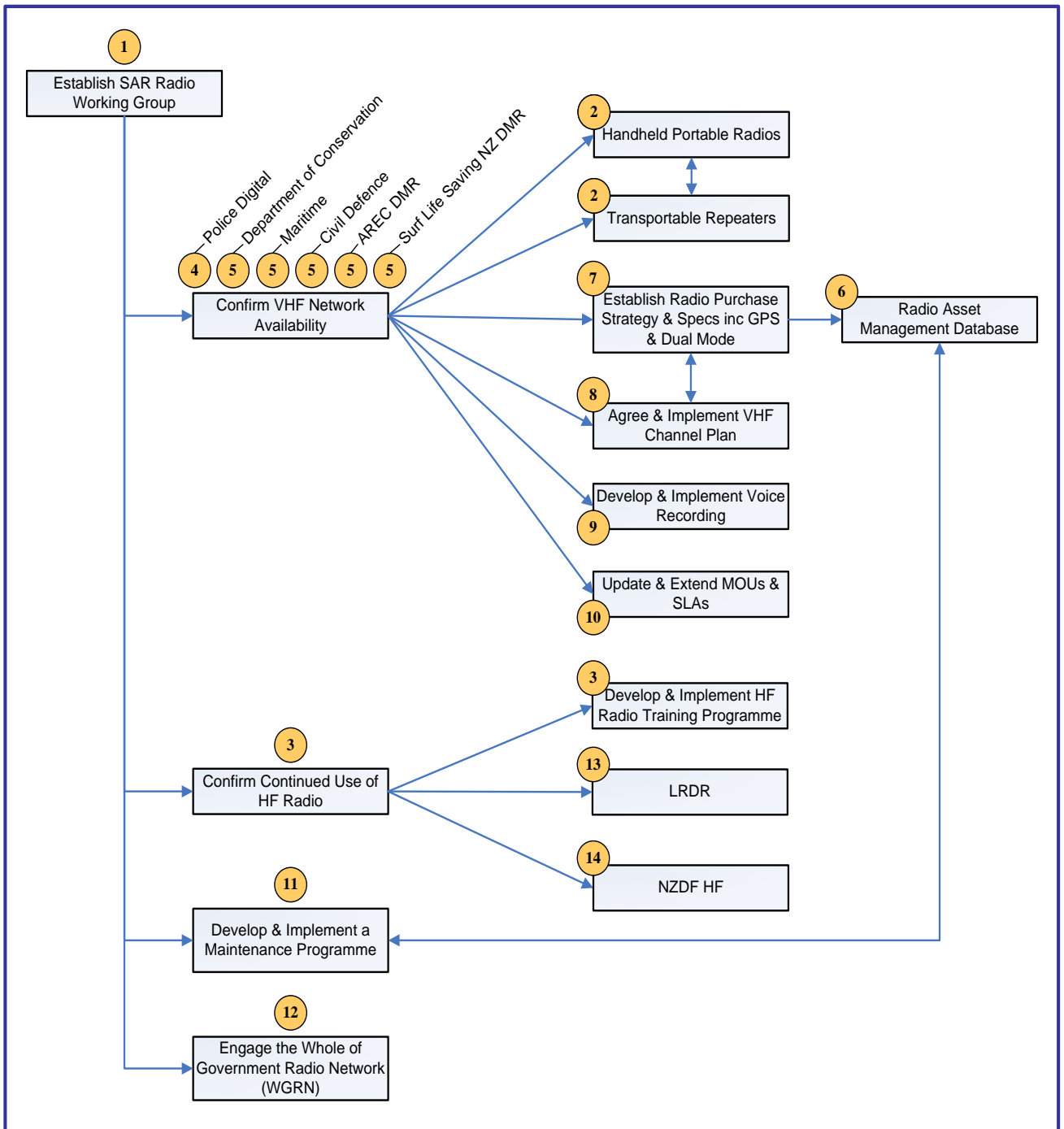
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7. Agree a common handheld radio purchase strategy that enables dual mode (analogue and digital) capability as well as built-in GPS for tracking.
8. Implement a common VHF channel plan for all radios to be programmed with nationally consistent channel names.
9. Develop and implement continuous voice recording and instant playback on appropriate VHF channels.
10. Update and extend Memorandums of Understanding to use DOC, Civic Defence and Maritime New Zealand's VHF networks as required for SAR activities.
11. Develop and implement a maintenance program for all radios, especially the non-Police owned fixed VHF radio stations.
12. Engage with the Whole of Government Radio Network (WGRN) programme to ensure the continued availability of HF and VHF radio networks for ongoing SAR training and operations.
13. Evaluate the cost/ benefit of acquisition, implementation and deployment of Codan LRDR.
14. Engage with NZDF to plan the future development of their HF radio infrastructure to support SAR operations and training requirements.

1.3. Dependency diagram

The dependencies between the recommendations are shown in the diagram below where the numbers correspond with each recommendation.

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1.4. Conclusions

Cellular networks provide the bulk of New Zealand’s land mass with mobile voice and data services. They operate at much higher frequencies than VHF radio and their coverage and performance is optimised to reflect high user density and usage in urban and main highway environments. A land-based search and rescue operation often takes place in a remote

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location and often in moist bush and forest where cellular coverage is limited or non-existent and performance is significantly degraded.

The Whole of Government Radio Network (WGRN) strategy envisages a resilient network with expanded national coverage based on Long Term Evolution (LTE) of the existing cellular network. This strategy could limit the development and availability of existing HF and VHF networks for future SAR requirements.

Radio generally provides point to multipoint communication which is essential during a typical SAR operation (SAROPS). Communications services provided by cellular and satellite technologies provide point to point communications that could be unreliable and unpredictable.

VHF radio is the preferred radio used by search and rescue teams in the New Zealand land environment, as long as there is sufficient coverage. Fixed and transportable repeaters provide a significant footprint for VHF handheld portable radios. However, there are many locations where VHF will not provide the required communication path back to the SAR Base.

Exclusive reliance on VHF radio technology means that communications may also be disrupted if repeater batteries go flat and/or aerials are damaged by wind or lightning.

HF radio provides a far greater coverage footprint than VHF radio and can be relied on to “get through” when other communications systems fail. However, HF radio has a reputation for being difficult to understand, setup and use. Components such as aerials and batteries, if poorly maintained, frequently fail when deployed.

The ramification of not using HF radio is that search and rescue teams could become isolated due to a lack of communications. This could compromise search team safety and efficiency, and overall command and control of a search and rescue operation (SAROPS).

Responsibility for the management and coordination of all land-based SAR incidents resides with New Zealand Police, with trained SAR coordinators and squads located in each of 12 Districts. The Police also own a large inventory of HF and VHF radios, base stations and repeaters for use during SAR events.

There is no appetite to change the existing SAR management and coordination arrangements. Closer strategic and operating alignment between the SAR community and Police on the retention and maintenance of their radio assets is seen as a priority.

HF and VHF radio services for SAROPS training and operations are provided via Memorandums of Understanding (MOU) between Land Search and Rescue New Zealand (LandSAR NZ) and the Amateur Radio Emergency Communications (AREC). Generally this arrangement works well at local SAR group level, subject to availability of experienced AREC volunteers. HF and

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VHF radio networks owned by other organisations such as the Department of Conservation can be utilised for SAROPS through national and local agreement.

The various MOUs and Service Level Agreements (SLA) need to be reviewed and updated to reflect changes in SAR communications requirements and the availability of additional radio services, features and applications.

Significant concerns

The following concerns have been identified during the development of the Integrated Communications Framework as areas to be noted and addressed on an ongoing basis;

1. SARTrack deployment – SARTrack is an incident management application that can be used to track search teams using GPS enabled radios. There is concern is that local groups are developing their own operating procedures around SARTrack without the guidance of a national deployment strategy. A radio asset management database will be required to uniquely identify each tracked radio.
2. Long Range Digital Radio (LRDR) using HF – An application has been developed to extend VHF radio back to a centralised incident management centre using HF radio. This application has been trialled in several locations with mixed results. The concern is that the evaluation process is fragmented, and that the costs and benefits of provision have not been adequately quantified.
3. Amateur Radio Emergency Communications (AREC) Digital Mobile Radio (DMR) – AREC is developing a DMR network independent of LandSAR. The concern is that the network is not compatible with current or future SAR VHF radio requirements and overlaps with the Police DMR network.
4. Police’s HF network – If Police disestablish their HF radio network, this would create a major hole in SAR radio communication coverage and potentially compromise the health and safety of search and rescue volunteers.
5. There is a concern that the Whole of Government Radio Network (WGRN) initiative is introducing LTE technology to replace conventional radio networks used by government departments. Engagement and participation in WGRN planning and implementation is necessary to ensure continued availability of HF and VHF radio for search and rescue activities.

1.5. Commentary

This section contains additional information and detail to support the conclusions and recommendations contained in the report.

1 Technical working group

- 1.1 A technical working group should to be established with representation from NZ SAR, Police, LandSAR, DOC, AREC, RCCNZ, NZ Defence, SLNZ, Civil Defence and Mountain

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Radio.

- 1.2 The working group's terms of reference should include frequency management, procurement policy, maintenance policy, channel names and plans, training and the evaluation of new applications and technologies.
- 1.3 NZ Search and Rescue (NZSAR) should take responsibility for the establishment and direction of the working group, to maintain national consistency and quality of communications policies and practices.
- 1.4 Training in radio communications needs to be standardised across the SAR community and learned skills need to be practiced and utilised whenever possible.
- 1.5 Radio equipment needs to be standardised in terms of functionality and frequency allocation, and all items need to be regularly tested and maintained.

2 New Zealand Search and Rescue (NZSAR)

- 2.1 NZSAR, with the technical assistance from AREC and NZ Police, should initiate and lead discussions on procurement and maintenance of land-based communication services for SAR operations. The key areas for discussion include:
 - The national procurement and maintenance of "next generation" handheld radios for SAR group use.
 - Implications for existing HF and VHF networks that are used for SAR activities with the implementation and expansion of an LTE-based Whole of Government Radio Network (WGRN).
 - The identification, testing and possible integration of new technologies into existing SAR operating procedures and procedures.
 - The establishment and direction of the Technical Working Group.
 - Permission from Coastguard to programme their new frequencies into SAR radios.
- 2.2 NZSAR should encourage search teams to use the POLSAR HF radios, and SAR Incident Base to actively use the Police and DOC HF radios with telephone interconnect.
- 2.3 NZSAR should encourage the provision of continuous voice recording and instant recall of VHF radio traffic terminating at each SAR Base.
- 2.4 NZSAR should work with AREC to explore the expansion of AREC's Digital Mobile Radio (DMR) network to provide digital VHF radio coverage outside the Police digital trunk radio (DMR) network.
- 2.5 NZSAR to work with DOC, Civil Defence and Maritime New Zealand to ratify the use of their networks for use on an as-required basis for SAR activities.
- 2.6 NZSAR should work with each CD Group to explore opportunities to utilise and share radio communications resources for civil defence and SAR operations.

3 New Zealand Police

- 3.1 Police should be asked to continue to support (either in house or outsourced) their VHF radio equipment used for SAR.

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- 3.2 Police should be asked to retain and maintain their existing HF radio network (either in house or outsourced).
- 3.3 Police should be asked to continue providing the resources required to establish and maintain a viable level of technical competence and capability necessary to maintain and operate their HF radio network.
- 3.4 Radios with digital trunk features can be used on the Police radio networks in Auckland, Wellington and Canterbury. Police should be approached to activate a non-encrypted SAR specific talk group to allow “non-Police” owned radios to use their VHF digital trunk networks.
- 3.5 Police should be asked to confirm whether their digital network can support GPS data burst traffic required for location monitoring services.

4 New Zealand Land Search and Rescue (LandSAR NZ)

- 4.1 LandSAR should ensure that a healthy relationship is actively maintained and fostered, particularly with AREC members at both executive and local branch levels.

5 Amateur Radio Emergency Communications (AREC)

- 5.1 AREC should continue to provide an essential component of SAR radio training and operational activities. The relationship between local Police and SAR with AREC groups should be monitored and actively managed to ensure their expertise and value is understood and appreciated.
- 5.2 There are Service Level Agreements (SLA) and Memorandums of Understanding (MOU) between AREC, LandSAR, Police and NZSAR. These documents need to be ratified to confirm that they are current, appropriate and enforceable.
- 5.3 A focus on deployment and maintenance of radio equipment is required as part of any SLA and training review.
- 5.4 A proactive membership retention and recruitment programme is required to maintain current levels of AREC personnel involvement with SAR training and operations.
- 5.5 Many AREC people contribute their own, privately owned VHF and HF radio equipment to SAROPS. This should be supported and encouraged but not taken for granted.

6 Department of Conservation (DOC) HF and VHF radio networks

- 6.1 DOC should be approached to confirm that their VHF and HF sites with telephone interconnect and several hundred VHF repeaters will continue to be available for SAR use.

7 New Zealand Defence Force

- 7.1 New Zealand Defence Force (NZDF) are about to implement a refresh program of their

HF radio network but they have yet to decide how many sites their new network will have. These sites could be used by LandSAR in the future.

- 7.2 A dialogue should be established with NZDF to provide input to their HF radio network refresh programme and ensure that its future capabilities are consistent with SAR requirements.

8 Surf Lifesaving NZ

- 8.1 There are possible interconnection scenarios to explore between SLSNZ and SAR radio channels. This should be examined by the proposed technical working group.

9 HF radio

- 9.1 Fixed HF radio stations which are owned and maintained by NZ Police and the Department of Conservation (DOC) should be retained and maintained, including the stations with telephone interconnect,
- 9.2 All HF radio equipment to be maintained regularly to an agreed standard by Police or their agent(s).
- 9.3 AREC should be contracted to provide nationally consistent training to search teams on the deployment and operation of POLSAR HF radios and to lead by example with radio procedure.
- 9.4 Search teams should take and use HF radios, particularly where there is potentially unreliable VHF coverage.
- 9.5 Opportunities for the use of the new NZ Defence HF radio system should be explored, once it becomes operational and available.
- 9.6 Applications such the Codan Long Range Digital Radio link (LRDR) using digital HF radio, multiple frequencies and Automatic Link Establishment technology should be critically evaluated, with LandSAR (assisted by AREC) providing national guidance and direction on their development, procurement and operation.
- 9.7 SAR agencies should manage appropriate national HF frequencies and pay the licence fees.

10 VHF radio

- 10.1 All VHF radios should be programmed with the same channel plan and channel names. The proposed technical working group should be tasked to design and implement this change as a high priority.
- 10.2 All VHF radio equipment should be tested and maintained regularly to an agreed standard.
- 10.3 The installation of additional fixed VHF repeater sites should be reviewed and managed on a case by case basis by the technical working group.
- 10.4 Some VHF repeater sites could be linked together to provide wider area coverage.
- 10.5 The acquisition of additional transportable repeaters should be considered.

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- 10.6 Liaison between SAR organisations and Regional Civil Defence groups is recommended to encourage better understanding of each other's VHF capabilities and requirements.
- 10.7 Radios should be purchased with built in GPS receivers so that tracking software can be used.
- 10.8 SAR agencies should manage appropriate national VHF frequencies and pay the licence fees.

11 Procurement with maintenance contracts of all radio equipment

- 11.1 A standard for the procurement and maintenance of all radio equipment should be developed and published. This work should be delegated as a high priority to the technical working group.

12 AREC Digital Mobile Radio (DMR)

- 12.1 There is a New Zealand wide network of linked Amateur Radio digital UHF (70cm) DMR repeaters based on the ETSI Digital mobile radio (DMR) standard. This network is growing in size. The AREC community uses this network to communicate with each other.
- 12.2 If this DMR network introduces VHF repeaters then it could be used in areas where the Police digital trunked network does not provide coverage. Currently there are six VHF DMR repeaters provided by AREC (three in Wellington, two in Dunedin, two in Southland).
- 12.3 LandSAR and AREC should work together to determine the benefits of further development of AREC's DMR network to incorporate SAR communications requirements.

13 Whole of Government Radio Network (WGRN)

- 13.1 It is anticipated that the proposed WGRN will reduce investment and maintenance of existing radio infrastructure such as the DOC HF network.
- 13.2 Discussions should be initiated with the WGRN governance group to emphasise the importance of existing HF/VHF radio networks for SAR operations and training, with the ongoing need for such networks in a future dominated by cellular radio services.

2 SAR Organisations' Radio Communications Capabilities

Responsibility for New Zealand SAR policy lies with the Government. Services are managed and coordinated by several core departments and state agencies, namely New Zealand Police, Maritime NZ, the Civil Aviation Authority, the New Zealand Defence Force and the Ministry of Transport. Other agencies, such as the Ministry of Civil Defence and Emergency Management, are responsible for wider and complementary policies regarding rescue activities.

The responsibility for the operational co-ordination of SAR operations rests with the Police and the Rescue Coordination Centre New Zealand (RCCNZ). Each body works to coordinate the activities of the many organisations in the SAR sector that provide people, communications and resources required to complete a SAR operation.

In practice, Police coordinates Category I SAR Operations (SAROPS) (local level land operations, subterranean operations, river, lake and inland waterway operations and close-to-shore marine operations) and RCCNZ coordinates Category II SAROPS (national level operations associated with missing aircraft or aircraft in distress and off-shore marine operations within the New Zealand Search and Rescue Region).

SAR agencies such as LandSAR and SLSNZ provide trained volunteers who carry out land- and water- based search and rescue operations. DOC is not a designated SAR agency, but for some areas such as Mt Cook they are the designated lead for SAR activities. DOC staff are often involved as members of search teams and DOC VHF radio repeaters are used in areas where they provide coverage.

2.1 New Zealand Police

The NZ Police are responsible for the management and coordination of all Category I SAR incidents within New Zealand. Police officers in each of the 12 Police districts are trained as SAR coordinators, and they are assisted by 24 Police SAR Squads located throughout New Zealand. In addition, the Police utilise their launches (based in Auckland and Wellington), Police SAR Squads, the Police dive squad and the Auckland-based helicopter for SAR operations. The Police resolve a high percentage of 'would be' SAR operations before any resources are committed to the operational field.

VHF radios used by Police for SAR

Police have a 75MHz Land Mobile Radio (LMR) network to connect their vehicles to their Communications Centres. The 75MHz network is NOT used for Search and rescue.

Instead Police use Tait TP9400 VHF handheld radios operating on the (ESB band) 138-144 MHz FM analogue radios with built-in GPS receivers. These handheld radios are supported

by transportable repeaters which are deployed to provide a coverage footprint for the search area of operation.

These ESB radios are the primary form of communication supporting SAR operations and Police should be asked to continue to support (either in house or outsourced) their VHF radio equipment used for SAR.

Police SAR radio inventory

The SAR radio inventory owned and maintained by Police is understood to include:

- 228 VHF hand-held radios (in kits of six portables). These radios have built-in GPS receivers
- 29 VHF mobile transportable base stations
- 33 VHF portable repeaters
- 236 HF POLSAR portable radios

The NZ Police own and maintain a number of HF radio stations that can be used for communicating with SAR field teams using the five watt POLSAR HF handheld portable radios. These include:

- 100 Watt HF radios attached to broadband aerial arrays at a number of Police stations throughout the country.
- Three HF radio sites owned by Police that can be accessed by telephone. These sites can all operate on SAR HF frequencies.

Refer Appendix 1 for a map showing where these HF radios are located.

The capability exists to access a digital radio channel over the Police's internal IP network. This means that a digital SAR radio channel can be accessed from any Police station in New Zealand.

Police issues

The Police's continuing role in coordinating and managing land-based (Category I) SAR incidents needs to be explicitly stated at both national and district levels.

2.2 Land Search and Rescue New Zealand (LandSAR NZ)

LandSAR NZ is a national organisation consisting mainly of volunteers that provides land search and rescue services when required by the SAR Coordinating Authorities. Services include suburban/urban and wilderness/rural SAR operations, underground SAR operations in caves or other natural underground areas, shoreline SAR operations linked to marine incidents, and other agreed SAR operations.

In the event of a land based search and rescue operation, volunteers are called out by the Police through the local SAR organisation at the group and regional levels. An Incident

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Management Team (IMT) is then formed, comprised of both Police and LandSAR volunteers.

LandSAR has over 2,500 trained SAR volunteers, who are members of 63 Land Search & Rescue groups, organised into seven regions, covering New Zealand. It includes two national specialist groups – LandSAR Search Dogs and LandSAR Caving. Other specialist groups such as Alpine Cliff Rescue and Swift Water Rescue operate on a local level where there is a requirement for these specialist skills.

LandSAR aims to ensure a minimum of two and an optimum of three handheld VHF radios is carried per search and rescue field team. They recommend the use of HF radio by search teams for secondary communications (or primary where VHF radio is ineffective). They are implementing a national radio battery maintenance programme and a single contact point for radio repair and maintenance.

LandSAR has 12 transportable repeaters and four, new design repeaters which can operate in either end or linking modes.

LandSAR issues

A nationally consistent approach to LandSAR radio equipment procurement and registration (i.e., asset management database) is required.

2.3 Amateur Radio Emergency Communications (AREC)

Amateur Radio Emergency Communications (AREC) is an associate member of NZART and a member of the New Zealand Search and Rescue (NZSAR) Consultative Committee. AREC members from 47 Sections form a network of amateur radio operators throughout New Zealand who provide communication services to support SAR, Civil Defence, sporting and other radio services.

AREC objectives include:

- Maintain a close liaison with the NZ Police and LANDSAR for Search and Rescue.
- Maintain a close liaison with Civil Defence in New Zealand.
- Maintain liaison with other community organisations.
- Provide and maintain suitable radio equipment appropriate to the emergency situation.

AREC members are volunteers. There are many, very experienced members who have worked with radio for many years. They have strong relationships with many search and rescue organisations (Police and LandSAR) throughout the country, and generally provide a good quality of service. However, there are parts of the country where the AREC does not have a presence and therefore cannot provide training or radio support to Police or LandSAR.

AREC is contracted via a Service Level Agreement (SLA) administered by NZSAR to provide a range of services to search and rescue organisations. AREC provides a wide range of advice

to organisations and groups including Police, LandSAR and helicopter operators on radio communications, and provides radio channel licences where required.

AREC Issues

Minimum standards need to be developed and maintained to ensure consistent training in the establishment and use of radio by SAR agencies.

A concerted effort to recruit and provide succession planning needs to be introduced to maintain a sufficient number of AREC volunteers for SAREX and SAROPS events.

2.4 Rescue Coordination Centre New Zealand (RCCNZ)

The RCCNZ is responsible for coordinating all major maritime and aviation search and rescue missions within New Zealand's search and rescue region, and land-based missions arising from someone activating a distress beacon. The Maritime Operations Centre (MOC), which is co-located with the RCCNZ, provides VHF and HF radio services for New Zealand's coastal waters and the South Pacific, including around-the-clock monitoring of radio frequencies for distress messages originating in NAVAREA XIV.

Generally, RCCNZ only communicates with Police or the MOC Control Centres. The rise in the number of Personal Locator Beacons (PLB) that are activated on New Zealand's landmass may necessitate direct communications between RCCNZ and SAR agencies during SAR events.

RCCNZ Issues

The RCCNZ sees a need to develop procedures for inter-agency communications and for passing information. This applies not only between communications centres, but also during SAR events. Maintaining compliance with these procedures will take ongoing training and mentoring.

There is currently no technical coordination or discussion between different SAR groups. RCCNZ would be keen to be involved in a technical liaison group for awareness and networking.

2.5 Maritime New Zealand (MNZ)

Maritime New Zealand owns and operates a Maritime Operations Centre (MOC) and a VHF marine radio network. Coastguard and Surf Lifesaving New Zealand use this network for their search and rescue activities. It also monitors CH 16 international distress and safety, and area working channels. All radio channels have voice recording.

MNZ also operates the Taupo Maritime HF Radio for oceanic distress on the HF international distress frequencies. It is the master control room for the VHF Maritime Radio Network of 30 coastal stations.

The MOC has IP based radio technologies allowing internet and smartphone access to VHF marine channels.

2.6 Department of Conservation

The Department is responsible for the oversight and upkeep of over 30% of New Zealand's landmass. It has developed an HF and VHF radio network to support its day to day operational requirements in areas without adequate telephone or cell phone coverage.

Many SAR incidents occur on DOC's estate, and DOC personnel often provide the initial response resource. At Aoraki/Mt Cook, DOC provides the high alpine SAR response on behalf of the NZ Police and this is covered by a Memorandum of Understanding between the DOC Area Office and the NZ Police. In addition, many DOC staff also volunteer their own time as LandSAR personnel on SAR events.

DOC's HF/VHF network includes 110 – 120 VHF repeater sites and 150 hut/base radios along with over 1250 VHF handheld and 700 vehicle mounted radios. It also owns over 150 portable HF radios and 10 HF base and hut radios. Six of the HF base stations have telephone interconnect. However, many of their HF radios are being phased out as satellite usage increases. DOC has over 80 satellite phones using the Iridium network that increasingly support DOC's day to day operations.

DOC makes their extensive HF / VHF repeater network available to support communications during SAR operations. Permission to access these repeaters and to program SAR radios from locations across New Zealand is generally arranged on a case by case basis between LandSAR and each local DOC Manager. A national agreement exists for channel usage.

DOC has programmed three of their HF stations (with telephone access) with SAR channels so they can be used to contact field SAR teams using their POLSAR radios.

A diagram of DOC's national VHF network and channel plan is shown in Appendix 1.

DOC Issues

Implementation of the Whole of Government Radio Network (WGRN) could affect DOC's future development and maintenance of its VHF and HF repeater network that is used to relay radio traffic during SAROPS in remote locations and mountainous terrain. This is a key issue to be discussed with the WGRN Governance Group.

2.7 New Zealand Defence Force

NZDF personnel and assets participate in SAR activities on an "as required" basis. The NZDF maintains a roster of personnel on call for any SAR events. NZDF resources available for commitment to SAR operation in the NZSRR consists of:

- P3K Orion aircraft (on two hours' readiness);

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- NH90 helicopters (on two hours' readiness) (A109A helicopters are only used for aircrew training)
- One Navy vessel at eight hours' readiness for oceanic SAR;
- One Navy vessel at four hours' readiness for coastal SAR;
- NZDF ground rescue parties on request; and
- Military manpower and other resources (aircraft, vehicles, equipment) on request.

It is expected that any defence team supporting a SAROPS will operate with their own radio communications package. Engagement of the NZDF to assist a particular SAR operation is generally arranged by New Zealand Police.

2.8 Rescue Helicopters used for SAR

All certified rescue helicopters are fitted with radios that operate on Police, Fire and Ambulance channels. Radios with all VHF SAR and marine channels are also installed. There are no HF radios installed in these helicopters.

Northland Emergency Services Trust

The Trust offers rescue helicopter services with the capacity to contact ground crews during a SAROPS. They have VHF radios hard mounted in their helicopters that are tuned for the Northland region LandSAR frequencies, but are not sure if these frequencies apply in other regions.

Southern Lakes Helicopters Ltd

SLH Ltd provides aerial support for SAR Operations. They provide advice at briefings for establishing correct communication lines between ground parties, SAR Base and search aircraft. Two helicopters which are fitted with HF systems that are available for use wherever their aircraft are deployed.

The company has a VHF transportable base that is able to be utilised for SAR operations if required. They operate two fixed repeater sites at high altitude locations that link back to an operating base at Te Anau and provide maritime and company frequencies that can be utilised for Civil Defence and Maritime operations.

Police have provided radio systems for SAR in all SLH aircraft. Radio communications systems to work with Civil Defence, Ambulance and Fire are also installed.

The company is willing to consider future upgrade requirements if necessary, in keeping with new SAR requirements and technologies.

2.9 Surf Lifesaving New Zealand

Surf Lifesaving New Zealand (SLSNZ) has over 19,000 members spread across 74 clubs nationwide. SLSNZ use VHF marine channel 69 and NZ Coastguard VHF radio channels for communications at club level.

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SLSNZ are three years into a 10-year project to modernise their radio communications. They are building a unique digital encrypted radio network consisting of a number of micro-networks connected with national control centres in Auckland and Tauranga. By 2020 in excess of 80% of their network will be DMR with approximately 45 repeaters throughout the country connecting multiple micro networks. These networks provide private voice and low speed data for GPS tracking and status messaging. Hand held radios can be programmed with digital and marine analogue channels.

The new digital network will use encrypted voice, real time GPS tracking and reporting. Interoperability between Surf Lifesaving, Coastguard and Police is planned in the future.

Currently the new digital radios are being used in Auckland and the Bay of Plenty.

SLSNZ has a radio control room alongside the Coastguard control room in Tauranga where they monitor national, real time activity by surf lifesavers. They are planning to install a 40 to 50 site digital radio network using UHF DMR radios provided by Logic Energy and Tait.

2.10 Coastguard

Coastguard New Zealand has 1800 volunteers crewing 75 rescue vessels around the country. Coastguard use VHF marine radio channels including their own exclusive repeater channels where they can operate in relative privacy in their area of operation. They also use local channel 16 and public secondary channels.

Recently the Coastguard VHF radio channels have been re allocated by the Radio Spectrum Management Office to enable some of their channels to be used as data channels. Some Coastguard repeaters have had to be programmed with different frequencies and some vessel radios are required to use different channels.

With all radio equipment used by Maritime Operation Centre now upgraded to IP based equipment there is now an opportunity for SAR groups to access these channels over the internet using computers and Smart phones.

Coastguard vessels and control rooms only have VHF marine radio channels installed. In South Taranaki, Coastguard vessels have been fitted with Police 75 MHz radios to enhance coverage for search and rescue activities.

See Appendix 3: Map of NZ showing marine VHF coverage.

Coastguard Issues

LandSAR frequencies cannot be programmed into Coastguard radios. Permission needs to be sought from the licence owner of the new Coastguard frequencies to programme them into SAR radios.

2.11 Ambulance

The Ambulance services are not generally involved in SAR operations, but may be present at a SAR Base or SAR HQ with their own ambulance radio communications.

Example: Dunedin Order of St John

Any Ambulance involvement would generally have a crew at the local SAR HQ /base with no radio capability other than normal Ambulance radio communications. Ambulance crews are not generally directly involved in SAR. If an ambulance does attend, crew are based at a search HQ where a SAR radio is provided. If an ambulance team does go in on foot, they will not be using a radio supplied by St John.

Ambulance services still make extensive use of Telepagers for ambulance operations to contact specialised team members for SAR, helicopter, water rescue etc.

Currently, ambulance services experience areas of poor VHF radio coverage that are not designed for portable operation. They are expected to join the P25¹ trunked network in Auckland, Wellington and Canterbury in the future. A program to add coverage in isolated areas and increase network (analogue) resilience to cater for the next five years is currently under way.

The emergence of cellular based options will augment current communications capabilities to a degree. Overall, the service is in a holding pattern whilst awaiting a future strategy for an Emergency Services radio network.

All ambulance VHF radios are programmed with ESB liaison repeater and simplex channels. These liaison channels are also programmed into all SAR, Police and Fire radios.

2.12 NZ Fire Service

NZ Fire Service vehicles operate on the NZ Police 75 MHz VHF analogue radio network to connect with one of their three Communications Centres. On the ground each fire fighter uses a handheld portable radio operating on the IGC (incident ground communications) UHF radio channels. There is no direct radio link from the IGC radios back to the Fire Communications centres.

The Fire Service provides a fire services command vehicle when requested to support a SAROPS. Their command vehicles that are fitted with radios operating on Police, Ambulance, SAR, Civil Defence, DOC and marine VHF channels.

¹ Project 25 (P25 or APCO-25) is a digital public safety communications standard dedicated to ensuring interoperability by public safety organisations to enable them to communicate with other agencies and aid response teams in emergencies.

The Fire Service also has an Urban Search and Rescue group that work during Civil defence emergencies in damaged buildings. They use UHF portable radios.

Fire Service Issues

The introduction of new IGC radios operating on the UHF band will prevent the Fire Service from communicating on SAR VHF radio channels. If deployed for a search and rescue operation, each command vehicle is able to communicate by radio to SAR base and SAR teams but individual fire fighters will be unable to do so.

2.13 Civil Defence

There is no direct engagement between SAR agencies and national or regional Civil Defence organisations to consider sharing resources, training activities or joint strategic planning. Discussions with individual Civil Defence Emergency Management (CDEM) centres around the country indicate a range of capabilities and abilities to support and augment communications during SAR operations.

Auckland CDEM

Auckland CDEM currently does not have any responsibility for SAR radio communications but maintains and operates an independent VHF system. However, they have a close working relationship with the Northern District AREC. Two communication hubs have been established with AREC branches and the CDEM Emergency Coordination Centre (ECC). Auckland CDEM has CDEM radio liaison with the Police Northern Communications Centre and Fire communications Centre via VHF radios installed in their ECC.

Auckland CDEM also has two VHF transportable repeaters, ES 164 (Emergency services liaison), ES 132 (portable incident repeater), and 9 VHF Fixed repeaters across the Auckland Region. They also own several HF frequencies (former MCDEM) and an HF base radio, as well as several Iridium Satellite phones and BGAN units.

Auckland CDEM offer the capacity to support land based SAR communications if required.

Wellington Region Emergency Management Offices

Wellington Regional Civic Defence has Emergency Management operations centres (EOC) located in Wellington, Lower Hutt, Upper Hutt, Masterton, Kapiti and Porirua. Each EOC has the ability to support SAR operations from a communications perspective, such as allowing the use of their channels in local area searches if the need arises.

They maintain a network of 27 fixed repeaters across the Wellington region, with one Police radio installed at their Wellington EOC and radio access to fire, ambulance, coastguard and RCCNZ communications centres. Emergency communications also include Iridium, Inmarsat and IPStar satellite phones at all EOCs.

Civil Defence Issues

Each regional council has developed its own civil defence operational plans and procedures including communications networks and equipment usage and management practices.

Civil Defence groups are in the process of modernising their radio assets.

2.14 Other Radio Network providers

Private Forestry radio networks

Forestry operations in the “green triangle” (Auckland – Hamilton – Tauranga) generally rely on intensive VHF radio networks to maintain contact with their felling crews and transport assets. This area also coincides with demand for SAR services where access to these radio networks could be of value.

In general, the forest owners are not keen to make their channels available for SAR radios to be programmed into them. However, there is a possibility that some of the forest companies would consider, on a case by case basis, making available some forestry portable radios with certain forest channels installed should the need arise. SAR organisations would need to contact the forest company representative at the time of the operation to arrange this, and the application would be considered depending on health and safety requirements, and what else might be going on in the forest at the time.

In the interests of health and safety, the forest managers ask to be contacted prior to any forestry being entered to carry out a SAR operation.

3 SAR Radio Communications – Issues and Challenges

The nature of SAR activities and the availability of communications technologies that could be used during SAR operations are evolving at an ever-increasing rate. The ability exists to equip each search team member with both voice and data communications, and transmit their location. The need for such connectivity however, needs to be balanced against acquisition and operating costs, and the overheads inherent in running and maintaining more complex networks.

3.1 Changes in communications technology

This section reviews the VHF and HF radio technologies and features that are available now and in the future, and their relevance to the SAR environment.

3.1.1 Why HF and VHF radios are required for SAR

New technologies have emerged to support mobile services to the extent that cellular communications are used extensively in place of traditional radio networks and services. However, the issues of resilience and reliability make cellular and other “line of sight” radio services unsuitable for SAR communications outside the major cities, towns and highways. The ability of VHF and particularly HF radio to “get through” under the most adverse conditions makes it an essential component of SAR communications.

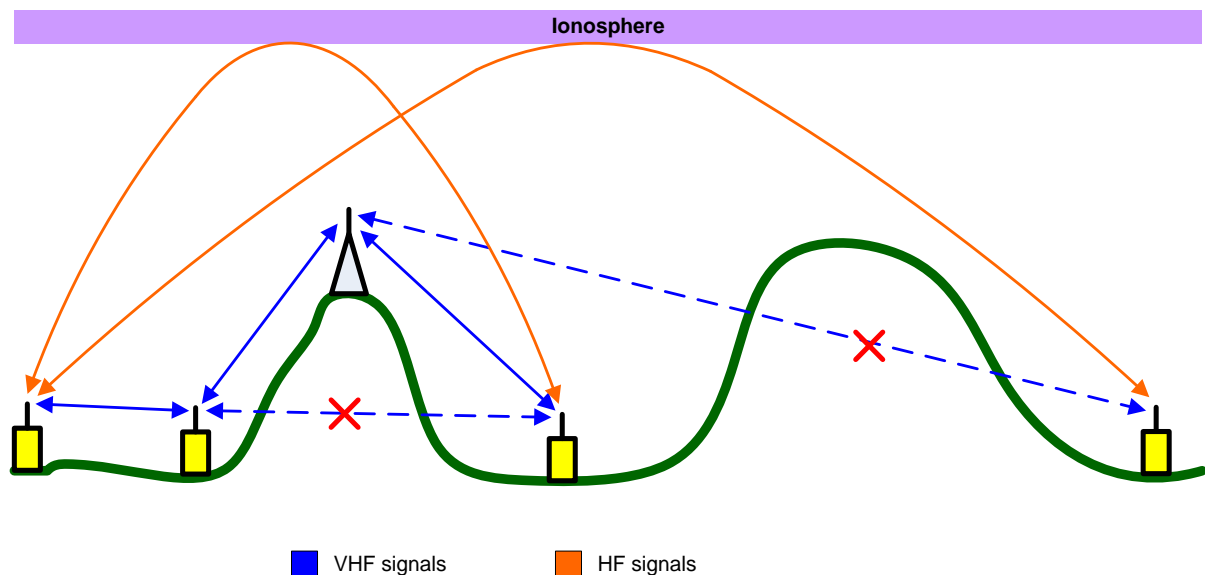


Figure 1: HF and VHF radio characteristics

While VHF radio signals cannot penetrate solid obstacles such as buildings and mountains, VHF range can be extended using either fixed or transportable repeaters. HF radio signals can be reflected off the ionosphere in the upper atmosphere, thus extending their range over

much longer distances than VHF signals. This is shown above in **Figure 1: HF and VHF radio characteristics**.

Fixed repeaters are dependent on batteries that are charged by mains or solar power that may be disrupted. They are often located in inhospitable sites where their aerial systems can be damaged by wind or lightning strikes which render them inoperative.

Transportable repeaters operate with lower gain aerials and lower transmit power than fixed repeaters. Poor weather and difficult terrain can prevent VHF transportable repeaters from being deployed during a SAR operation.

3.1.2 VHF Radio for search and rescue

Current situation

Very High Frequency (VHF) radio equipment, operating on the Emergency Services (ES) band is the primary means of communication for land search and rescue in New Zealand. VHF provides reliable, good quality analogue voice performance with 'line of sight' handset to handset and extended coverage when repeaters are used.

VHF handheld portable radios that are commonly used in SAROPS are made by different manufactures (Tait, ICOM) and owned by different organisations (Police, LandSAR, DOC and AREC).

To provide the required coverage between radios in the field, radio repeaters are used. These repeaters are either permanently installed at fixed locations or are transportable. Transportable repeaters are in storage ready to be deployed as and when required.

The fixed repeaters are owned and maintained by Police, DOC and AREC and the transportable repeaters are owned by Police and LandSAR NZ.

There is also a small quantity of transportable 'back to back' trigger link radios owned by Police and a small quantity of repeaters accessed by UHF link radios owned by AREC.

The quantity of hand held radios around the country is significant with a typical search team of three or four people carrying at least two radios. This equates to approximately 5,000 handheld units that need to be maintained for immediate use.

All radios use modern rechargeable batteries which can last an eight-hour search period. A spare battery is also provided with each radio during field deployment.

GPS tracking Features

Police-owned radios and many LandSAR and AREC radios have built in GPS receivers that can be 'followed' by the SARTrack system. Extension speaker microphones with built in GPS receivers provide this facility on current LandSAR radios.

Marine channels

Coastguard Radio monitors and broadcasts over VHF Channel 16.

Emergency Services (ES) band VHF band radios are also capable of operating on the marine VHF frequencies which enables search team to operate with Coastguard vessels and rescue helicopters.

Police digital trunk radio networks.

Police own and operate three VHF digital radio networks (referred to as the Replacement Radio Network) that provide very good coverage for general duties policing in Auckland, Wellington and Canterbury. This network is digitally encrypted and uses the trunking feature. The analogue radios currently owned by LandSAR, AREC and DOC cannot use these Police networks. However, Police owned VHF handheld portable radios can operate on a dedicated talk group which is not encrypted.

Future Whole of Government Radio Networks

The existing Replacement Radio Network (RRN) installed for Police will not be extended beyond its current coverage. While emergency users including Fire and Ambulance will be encouraged to utilise the RRN where it is available, the ongoing focus will be development of the Whole of Government Radio Network (WGRN) based on Long Term Evolution (LTE) of the cellular network (see Section 3.6).

VHF radio repeaters for SAR

VHF radio signals generally travel in straight lines and can be blocked by hills and mountains. To extend their range, VHF radio communications must be retransmitted via a repeater.

Police transportable repeaters

The primary form of radio repeater used for SAR is the VHF transportable repeater supplied by Police and LandSAR (see Figure 2). There are 4 VHF channels that these repeaters can be deployed on and there is a small quantity of transportable 'back-to-back' trigger repeaters that can be used to link the transportable repeaters together.

These repeaters are deployed by Police officers, LandSAR volunteers and AREC volunteers using helicopters, 4WD vehicles and/or walking to a suitable location at the beginning of each SAR operation. Often the weather is poor which affects the deployment time.

There is a perception that the transportable repeaters are unreliable once they are deployed. This is generally the result of poor maintenance of power supplies and aerials rather than the repeater units themselves.

LandSAR portable repeaters

LandSAR has 12 transportable repeaters and four, new design repeaters which can operate in either end or linking modes.

Civil Defence portable repeaters

Discussions with Auckland and Wellington Regional Civil Defence indicate that both organisations own VHF portable repeaters which are deployed for relay of emergency service liaison and incident management.



Figure 2: Police Portable Repeater equipment and aerial assembly

Fixed VHF radio repeaters

Where statistics have shown that many search and rescue operations have occurred in a particular area, funding has been raised to build permanent radio stations.

Additional funding for more fixed station repeaters may be justified to minimise the time that the transportable repeaters take to deploy. Transportable repeaters often have to be flown to an appropriate high point by helicopter – an exercise that is often affected by bad weather.



The four VHF repeater channels used by the transportable repeaters cannot be used for fixed radio stations due to channel management and frequency licencing issues.

There are fixed repeaters covering most of the Wellington and Wairarapa search areas along with repeaters on Mt Taranaki, the northern part of the South Island, Wairoa and the Bay of Plenty. The frequencies used by these repeaters are licenced either by NZ Police or the AREC. Maintenance of these repeaters is carried out by AREC or through other local arrangements.

These repeaters are generally ‘stand-alone’ with no linking to other repeaters. All VHF handheld portable radios are programmed with these fixed repeater channels on a per-region basis.

Mobile radios used as base radios in the SAR base are generally connected to high gain aerials on a mast, with one radio for each channel in use.

DOC Fixed VHF radio repeaters

The New Zealand Department of Conservation (DOC) have a number of ‘standalone’ fixed VHF repeaters located through the country. The VHF radios used by SAR have all of the DOC channels programmed into them and DOC has given permission to use their radio repeaters during SAR emergencies and exercises.

AREC fixed repeaters.

AREC supplies and installs fixed repeaters for land based SAR operations through the country as follows (this is not a complete list as some MS08/MS17 data is incomplete):

EE122 repeaters / location

COLONIAL KNOB PORIRUA BP31 513.58 426.16
HIGHCLIFF DUNEDIN CE17 132.79 162.56
HUIA STREET KAPITI BP32 762.22 750.40
KOHUKOHUNUI AUCKLAND BB33 977.08 993.83
MANUOHA WAIROA BG40 586.73 133.67

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PARIWHARIKI TRIG WAIRARAPA BP35 289.84 460.75
PIHANGA TARANGI BH35 396.34 749.62
CAPE EGMONT -39.276266, 173.755020

EE196 repeaters / location

KAHAROA BAY OF PLENTY BF40 685.00 476.00
MT HOLDSWORTH TARARUAS BP33 035.84 724.83
WRIGHT HILL WELLINGTON BQ31 446.78 260.89
NEW PLYMOUTH POWER STATION CHIMNEY -39.057338 174.027478

MS17 repeaters / location

OTARAOA ROAD NORTH TARANAKI (Egmont coverage) -39.065227, 174.302735
CROWTHER WAINOUMATA BQ32 641.77 280.86
MT MISERY TAURANGA
ROYS PEAK WANAKA CB12 869434

MS08 repeaters / locations

MANAIA SOTUH TARANAKI (Egmont coverage) -39.551229, 174.124173

Fixed repeater management and maintenance

Key issues to be addressed to ensure repeater coverage is consistently provided and maintained across New Zealand include:

- Documentation showing where the fixed repeaters are, and what coverage they provide, needs to be brought up to date as the current information is incomplete.
- A program to keep fixed repeaters maintained needs to be developed and implemented.
- Frequency licencing should be financed and administered by a single organisation.
- Linking of repeaters to provide greater coverage should be investigated, designed and implemented where applicable.

Channel plans

Even though most VHF radios have the same channels in them, and therefore can communicate with each other, different SAR organisations have programmed their radios with different channel plans which use different names for the same frequencies. This has been identified as a major issue which causes confusion when the different organisations come together for the same search and rescue operation.

Non-commercial nation-wide VHF networks

DOC, Civil Defence and Maritime New Zealand provide nation-wide VHF networks (non-commercial) that exist independently to fulfil their specific requirements. There is an opportunity to utilise these networks on an as-required basis to support SAR activities.

3.1.3 HF radio for search and rescue

Current situation

All Police search and rescue groups have at least six POLSAR HF handheld portable radios. These radios are based on the SR3 radio used by the Mountain Radio organisation.

Each search and rescue team generally carries one POLSAR radio which is used when the VHF radio equipment cannot provide the required communications connectivity.

The POLSAR radio operates at five watts and is equipped with three frequencies which are called SAR day, SAR night and Police 6. The latter frequency provides an option to the SAR day frequency during the afternoon time period.

There are a number of high powered HF radio transceivers installed in Police stations around the country to communicate with the POLSAR radios in the field. There are also three high powered HF radio stations own by Police and three high powered radio stations owned by DOC that operate on SAR frequencies. These six radio stations can be remotely accessed with telephones.

AREC also provide high powered HF radio stations at fixed locations such as the Hood Aerodrome near Masterton and in the Canterbury AREC communications vehicles.

With training provided by the AREC, each search team can deploy and use HF radio when there is no other form of radio communications available.

The future for HF radio

With cellular telephone coverage growing and satellite telephones becoming more available there is a tendency for HF radio not to be used and to be considered “old fashioned radio” and thus no longer required.

There are many areas in the country where the cellular infrastructure does not exist and satellite phones do not function reliably. This situation will not change markedly with the introduction of LTE networks based on cellular technologies. HF radio will still work as a last resort in these areas and under adverse circumstances.

The “get through” capability of HF radio means that it should continue to be maintained and used wherever possible.

Long Range Digital radio (LRDR) using HF

Search and Rescue teams in the western and southern parts of the South Island often suffer with unreliable radio communication in their search areas. The mountainous terrain provides little access to cellular and satellite phone services. VHF radio does not provide the required coverage and the POLSAR handheld portable radios are ‘guaranteed not to work’ according to many users.

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An enhanced HF 'end to end' radio link using digital technology and automatic frequency establishment has been developed and preliminary tests indicate its potential to provide radio communications in the high country of the South Island West Coast and Southland. The LRDR solution should be assessed in a series of structured scenarios to determine its feasibility and effectiveness in 'real life' situations.

NZ Defence opportunities

New Zealand Defence is about to 'refresh' its 20-year-old HF radio stations located throughout the country. They are still in the planning stages and are inviting organisations like the Police and LandSAR to provide users' requirements to assist with the design capabilities and capacities of the new HF radio stations.

It is likely that this new HF radio system will be part of the NZ Whole of Government Radio Network program with the possibility of some HF radio circuits being made available for search and rescue operations.

The NZ Defence HF radio station will be designed for long range ship to shore radio communication to the South Pacific and Asia with aerial farms associated with each station, allowing aerial configurations that can be remotely changed to provide shorter, in-country HF radio coverage using the Near vertical incidence skywave (NVIS) aerals.

The HF stations are connected together with the Defence IP networks, so that circuits on specific frequencies could be made available for search and rescue requirements.

Service Level Agreements should be developed so SAR services can ensure access and availability when required.

RNZAF helicopter access to SAR radio channels

The two new helicopter types owned by the RNZAF are the A109 and NH90. Both helicopter types have the same radio communications equipment on board using the Wulfsberg RT 500 communication equipment. Any HF and or VHF radio frequency can be dialled into the Wulfsberg by the aircrew to enable radio communications with SAR field teams and SAR Base/HQ.

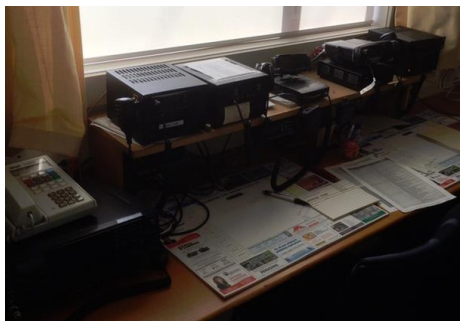
The RNZAF also have vehicles fitted with HF and VHF radios that will operate on SAR radio channels. LandSAR managers need the ability to advise aircrew on which SAR channels are being used on the day of the SAR operation.

3.1.4 Radio and Telecommunication (ICT) equipment at SAR Base

A SAR Base is set up to run each search operation. There are a number of dedicated SAR Bases around the country. Some are established in Police stations and others are set up by AREC.

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There is also a small quantity of buses set up as communications vehicles that have all the required radio equipment.



The SAR base will generally have the following equipment:

- At least two analogue telephone landlines providing voice, fax and internet.
- Cellular phones if coverage is available.
- Internet connections using landline ADSL, Cellular 4G and BGAN and/or IP STAR satellite phones.
- Printers and scanners (colour)
- HF 100 watt base radio with broadband dipole aerial attached to mast (supplied by AREC). (HF telephone interconnect can be used instead)
- VHF mobile radios with 12 volt power supply connected to high gain aerials on masts. One radio for each channel being used.
- Aviation VHF AM radio to communicate to helicopters
- Marine VHF FM to communicate with boats such as Coastguard.
- Battery charging for all type of handheld portable radios.
- Spare batteries for POLSAR HF portable radios.
- Uninterrupted Power Supply (UPS) / high capacity batteries to provide power to communications equipment if mains power is not available
- Petrol generators to provide mains power if nation grid unavailable.
- Computer Local Area Network (LAN) to connect computers to each other and to printers and the internet. (This is often a Wi-Fi network)

Future enhancements planned include:

- Voice recording of VHF radio channels.
- Computers with software connected to VHF base radios for tracking field teams using VHF portable radios with built in GPS.

3.2 Changes in SAR communications expectations

The requirement for effective and reliable SAR communications is expected to continue regardless of any change to the location or duration of search activities. Urban searches are likely to use cellular services where available, and utilise cellular functions such as text and data transfer. However, there is no guarantee that cellular coverage will be available

in all urban/metropolitan locations, and search teams should be equipped with VHF communications equipment as a minimum.

For searches outside reliable cellular coverage, there is no expectation that the use of VHF radio will decline. Greater awareness of incident management applications such as SARTrack is expected to increase demand for such services, and pressure for GPS-enabled equipment to be widely available will also increase.

A perception that HF radio is difficult to set up and use needs to be addressed. Currently, confidence levels in the set up and use of HF radio equipment varies between different SAR groups. This particularly relates to the provision of training and the availability of AREC volunteers when needed to manage HF communications during SAREX and SAROPS.

There are concerns that the Police may become less involved “on the ground” and opt to fulfil their SAR lead role from Command and Control centres. This will require radio equipment and networks to support long distance voice and data communications capability to SAR HQ and potentially, search teams.

3.3 Options available for the supply and maintenance of communications assets

Currently each organisation manages its own purchase and maintenance arrangements with manufacturers. This has resulted in a diverse range of equipment being available, with different standards and operating procedures being apparent. An “ad hoc” approach to supply reduces overall buying power and leverage with manufacturers, both in terms of obtaining an optimal price and also a wider range of features that are available through high volume purchasing.

Implementation of the Whole of Government Radio Network (WGRN) and the intention of organisations such as the Fire Service to move their radio capabilities to the UHF spectrum is creating uncertainty about what the next generation of SAR radio equipment should provide in terms of standards, features and accessories.

There is a lot of equipment held at depots across the country, without an overall plan for its maintenance and upgrade to latest versions of firmware. LandSAR has initiated a procedure for receiving faulty handsets from SAR groups and arranging their repair with manufacturers through a single contact point. The procedure also includes a battery replacement programme that is being implemented with each local SAR group. This proactive maintenance model appears to be working well and could provide a model for a consistent approach to maintenance that ensures equipment is up to date and fully charged when required.

3.4 The availability of required resources and expertise

AREC Volunteers

Because AREC members are expert in the field of radio communications they are expected to provide a full range of radio services to the search and rescue organisations. These include:

- General maintenance including preventative and troubleshooting of HF and VHF radio equipment
- Effective deployment of radio repeaters and base station radios including best practice for aerial installations and battery backup.
- Expert knowledge on the use of the HF telephone interconnect systems.
- Expert knowledge on the use of VHF handheld portable radios.
- Expert knowledge on the performance and coverage of local VHF radio repeaters.
- Providing an operational channel plan for each search and rescue operation.
- Assisting all search field teams to check their radio equipment before they go into the field.
- Effective training on the use of HF and VHF radio equipment to the search teams.
- Providing a professional operation of the radios to get information to and from the field teams leading by example.
- Effective message management and recording.
- Effective map reading skills.
- Keeping up to date with current search and rescue techniques by participating in appropriate Land SAR training courses.
- Becoming familiar with the new SARTrack application.
- Assisting evaluation of the proposed LRDR system.

Minimum standards need to be developed and maintained for these services.

A trend towards an older average age of AREC volunteers means that robust recruiting and succession planning need to be introduced to maintain an adequate number of AREC personnel.

3.5 Costs, funding and affordability

The cost of a SAROPS is met by the respective Coordinating Authority, i.e. Police or RCCNZ. There is no indication that this funding arrangement is likely to change. However, the costs of maintaining SAR readiness in the form of personnel training (classroom and field-based exercises), equipment provision and maintenance, and the availability of national networks (e.g. the Police HF network) and resources skilled in their maintenance and management by the Coordinating Authorities are continually under review.

The increasing availability of location devices such as Personal Locator Beacons (PLB) may result in more rescue- only rather than full-scale search and rescue activities. However, the

need for trained volunteers with modern, well-maintained equipment will not change so that the cost of sustaining New Zealand's SAR capability will not reduce.

3.6 The whole of government radio network project

The Police Replacement Radio Network (RRN) Programme was established in 2008 to focus on the development of a digital radio network for operational policing purposes and migration of Police onto that network, initially in the Wellington, Auckland and Canterbury districts, followed by the rest of New Zealand. A Whole of Government Radio Network (WGRN) was subsequently envisaged, utilising and expanding the RRN to enable the development and deployment of a radio communications for use by Public Protection and Disaster Relief (PPDR) agencies².

Long term future using LTE (Long Term Evolution) radio networks.

With the increased requirement for high speed broad band radio networks to transport high capacity data and video streaming, the New Zealand Government is looking at a Long Term Evolution (LTE) cellular solution.

LTE is a wireless broadband technology designed to support roaming Internet access via cell phones and handheld devices. LTE architecture is based on Internet Protocol (IP) to support browsing web sites, Voice over IP (VOIP) and other IP-based services and can theoretically support downloads at 300 Megabits per second (MBps).

LTE service is only available in limited geographic areas. Cellular providers such as Spark and Vodafone have joined with radio manufacturers including Motorola and Tait to develop 4G networks for emergency services to use. When these networks are brought into service there will be an opportunity for search and rescue organisations to take advantage of the coverage and features the LTE network will provide.

The subsequent development of the WGRN strategy envisages an RRN operating within its current boundaries in Auckland, Wellington and Canterbury. Existing conventional networks will be constrained to current areas of operation while a replacement strategy using LTE (long term evolution) technologies, principally cellular will be implemented.

Other aspects of the WGRN strategy that may affect SAR organisations' continued use and development of radio networks include:

- Overcoming issues of coverage and resilience in current cellular networks are a key component of the WGRN strategy.
- Agencies using conventional analogue networks will be required to develop migration strategies to an LTE environment with broadband data capability for their future mode of operation.

² Whole of Government Plan for Public Protection and Disaster Relief Radio Communications. April 2010

- Emergency services including fire and ambulance will be expected to utilise the RRN where it exists.
- Implementation of the WGRN strategy will affect LandSAR agreements to use radio equipment assets such as the Department of Conservation's fixed HF and VHF repeater network.
- Further purchases of radio equipment (including handsets) should incorporate the dual mode P25 standard i.e. both analogue and digital capabilities.

3.7 The capabilities and versatility of modern VHF and HF communications systems

HF radio use

The high frequency band (3 – 30 MHz) is effective for users who require direct, long-distance communications. The number of marine, aviation, military, and diplomatic/embassy users has declined in recent years in favour of less volatile communication technologies such as satellites although HF stations have been retained for back-up purposes.

However, countering this trend, the development of Automatic Link Establishment technology based on military standards for automated connectivity and frequency selection, along with the high costs of satellite usage has resulted in an increase in HF usage among traditional users. The development of higher speed modems which support data rates up to 9600 bit/s has also increased the usability of HF for data communications. Other standards development provides for error free data communications through the use of ARQ protocols.

VHF radio use

Propagation characteristics of the very high frequency band (30 – 300 MHz) are suitable for short-distance terrestrial communication just beyond the line of sight. VHF transmissions are restricted to the local area but are less affected by atmospheric noise and interference from electrical equipment than lower frequencies.

UHF radio use

UHF is the most commonly used frequency band (300MHz – 3 GHz) for transmission of television signals, mobile phones and the Global Positioning System (GPS). UHF is widely used for two-way radio communication, usually using narrowband frequency modulation (FM) and increasingly digital services. UHF is limited to line of sight transmission and reception but has the ability to penetrate buildings and is less susceptible to electrical interference.

Military radio developments

Military services demand networks for tactical voice, data and video communications that are versatile and reliable with easy radio integration and connectivity. Different systems need to talk to each other without disconnection. Older radio systems are not designed to connect to broadband IP-based networks nor are current radios capable of forming ad hoc networks with minimal configuration changes.

Both New Zealand and Australian military defence forces' vehicles and platoons rely on very-high frequency (VHF) Combat Net Radios (CNR). The battlefield role of the VHF CNR is complemented by handheld UHF radios and by a backbone of wideband high frequency (HF) backpacks.

The use of software-defined radios (SDR) is becoming widespread where SDR allows a single radio to operate in multiple waveforms for a wide range of capabilities. The ability to coordinate with foreign militaries, as well as within services of a single armed force, is also critical.

Satellite communications (Satcom) technology is widely utilised in tactical communications but HF communications continue to be used where satellite communications are finite and overburdened. HF radio's key advantage is its beyond-line-of-sight application for a fraction of the cost of a Satcom signal. HF radios have also increased their data transmission capacity, thereby allowing messaging and situational awareness to be integrated into command-and-control (C2) networks. Due to size and weight reductions, HF radios are now commonly used on foot patrols. Another advantage is the use of Automatic Link Establishment (ALE) which means HF radios can be operated without detailed technical expertise.

The above summary of military radio usage offers a number of parallels with radio use in the SAR environment – the need for reliable communications between team members and the wider command and control networks; that interwork with other SAR organisations; be easily configured and operated; and be cost-effective while offering both voice and data communications capabilities. There is also an expectation that military applications eventually become available for civilian use and hence part of future SAR communications service options.

3.8 Location based services including live tracking of SAR VHF radios

Tracking systems are designed to provide near real-time information on the location of search team members. Current practice is for search teams to transfer their location on a topographical map using NZMG coordinates back to the search base via radio. The coordinates are entered onto a similar map at the search base.

This approach is time-consuming, cumbersome and potentially inaccurate. A GPS-based tracking system for each SAR search team termed SARTrack has been devised using commonly available tracking hardware and software based on publicly available software.

The availability and use of location-tracking applications is recommended to support all types of SAR operations and ensure that health and safety aspects of search and rescue activities are satisfied.

SARTrack issues

The SARTrack database needs to be capable of dynamically editing radio identification numbers so that handheld radios' identification numbers do not need to be manually altered for GPS tracking.

It is unclear whether the Police network can support GPS data burst traffic and hence may not be available to fully support SARTrack and similar GPS-based location monitoring.

3.9 “Network as a Service” (NaaS) communications

Opportunities may exist to contract SAR radio requirements, including procurement, implementation, management and maintenance of radio services to an open standard, similar to the P25 standard.

Organisations including Spark, Vodafone, Teamtalk, Tait, Icom and Motorola are possible contenders to offer NAAS communications that are underpinned with comprehensive and enforceable Service Level Agreements

Currently Spark and Vodafone provide a mobile COW (cellular on wheels) unit for temporary coverage of events such as rock concerts and large sporting events. Police and Fire have contracts with both Spark and Vodafone to use these units if required. These could be utilised in a SAROPS event if necessary.

3.10 The need for and provision of internet capabilities for land based SAR operations

In search areas where reliable 4G cellular coverage is available, SAR teams using a SMART phone can access the internet. They can send and receive emails with good quality photographs attached and their location can be tracked using the phones built in GPS.

Wellington SAR teams are often sent tasking messages via email on the cellular network. The issue is the lack of reliable cellular coverage in the hills surrounding Wellington where the search teams are operating.

The need for and benefits of internet access for search teams in areas not covered by reliable 4G cellular services needs to be explored further.

3.11 Analogue versus digital network services and operations

Digital radio offers advantages over analogue radio in the areas of security, data transmission and reception, spectral efficiency and speech clarity. Note that digital low speed data only is available, limiting its use to messaging and the exchange of GPS information.

Digital radios make use of IP-based networks that enable wider interoperability and connectivity.

Spectral efficiency means digital radio makes better use of allocated channels than analogue systems. This may be significant in the future as demand for spectrum space increases.

One immediate advantage of digital radio is clear audio where noise and interference can be screened out more effectively to the limits of coverage. This means clearer audio over greater distances under operating conditions.

In New Zealand, digital radio services are provided on the Police network that covers their Auckland, Wellington and Canterbury districts and regions.

Note Section 3.6 (Whole of Government Radio Network) where funding for agencies' expansion of their existing analogue radio networks is to cease and new radio transceiver purchases should comply with the dual mode P25 standard.

3.12 Encryption of operational SAR communications

Voice channels on the Police's digital network are encrypted for operational security reasons. SAR groups have not shown any enthusiasm for encryption of SAR VHF channels and are happy with the current practice of using codes to relay sensitive information.

3.13 Satellite based operational communications

The use of satellite telephones (Iridium, Thuraya, BGAN etc.) is often promoted as an alternative to radio in areas remote from terrestrial fixed line and cellular service coverage. However, SAR operations are often carried out in areas that cannot guarantee "line of sight" to communications satellites. This particularly applies for terrain in the lower west coast and southwest corner of the South Island. In this case, VHF and particularly HF radio provides the most reliable option for communications between search teams and the SAR Base.

3.14 Compatibility with marine and aviation SAR communications

There appears to be no standard approach to communications between SAR teams and

aircraft or marine assets. Emergency helicopters generally have access to SAR teams via VHF and/or HF radio communications if the local frequencies have been agreed in advance. Often AREC groups will have the means to establish aircraft communications but this may not be always the case.

Marine radio communications are similarly based on local arrangements. These may be affected with the impending changes to some Coastguard frequencies later in 2016.

3.15 MNZ and RCCNZ communications arrangements

Maritime New Zealand (MNZ)

Maritime New Zealand's Maritime Radio Service (Maritime Radio) is responsible for maintaining VHF and HF radio services for New Zealand's coastal waters and much of the South Pacific Ocean and Tasman Sea. The services it provides include monitoring radio frequencies for distress messages 24/7.

The region covered by the New Zealand Distress and Safety Radio Service is known as NAVAREA XIV which extends from the middle of the Tasman Sea to the mid-Pacific Ocean, and from Antarctica to south of the equator. Maritime New Zealand (MNZ) is responsible for broadcasting Maritime Safety Information (MSI) within this NAVAREA.

MSI includes meteorological information, coastal and oceanic navigational warnings, ice accretion warnings and ionospheric prediction forecasts. The service provided by MNZ is complemented by a network of volunteer private radio operators located around New Zealand and its offshore islands. The network is monitored at all times by staff working at the Maritime Operations Centre (MOC), co-located with the Rescue Coordination Centre New Zealand (RCCNZ).

The Maritime Radio Service comprises 30 coastal VHF stations. Of these stations, 28 provide VHF radio coverage throughout the coastal waters of New Zealand. The other two stations provide VHF radio coverage in the coastal waters of the Chatham Islands. There is also an oceanic MF/HF radio station located east of Lake Taupo. All stations are linked to the MOC. It coordinates the transmission of all MSI on voice HF and VHF, as well as navigational warnings broadcast over the Inmarsat SafetyNET satellite system.

Rescue Coordination Centre New Zealand (RCCNZ)

RCCNZ uses multiple methods for communicating with SAR field units, including cell and SAT Phones, the marine distress radio network, relay messaging via the DOC, LandSAR or Police land based radio networks and replaying messaging via other coordination centres e.g. Ambulance and Police Communication Centres.

The primary method of communications is by telephone either directly to a SAR unit or via a third party with access to the most suitable radio network. This use of multiple means of

INTEGRATED RADIO COMMUNICATIONS FRAMEWORK FOR NEW ZEALAND LAND-BASED SEARCH AND RESCUE OPERATIONS

communication systems can cause confusion as several different systems may need to be used for the one incident; messaging can get corrupted through relaying and there are spots where communication is almost impossible.

RCCNZ does not normally directly task land SAR units as this is done via the NZ Police. Their main interest is in communicating with rescue helicopters. Although these are aviation based, they often use the land based repeater networks to communicate.

4 SAR radio communications framework

Factors considered in developing an integrated SAR radio communications framework include:

Purpose and goal

“Affordable and sustainable radio communications that efficiently and effectively support all search and rescue activities while assuring the safety of SAR personnel and the public.”

Framework principles

Principles that underpin the framework include:

- Reliable – Dependable, replicable communications when/wherever required
- Usable – SAR teams can set up and operate the radio equipment under all conditions
- Available – radio services can be established where required on New Zealand’s landmass
- Effective – radio equipment and services (voice, data etc.) that are appropriate to the situation
- Sustainable – cost effective, environmentally sound, support SAR health and safety policies

Framework elements

Relevant elements include:

- Equipment
- Workforce
- Incident management
- Coordination
- Stakeholder management
- Protocols
- Environment management

Challenges

Challenges that are highlighted by the framework include:

- Availability of technical expertise to train radio users and manage SAR communications
- Agreement for a common radio communications channel management strategy.
- The implementation of efficient and effective maintenance plans that ensure that all equipment is updated to the latest versions of firmware, charged and ready for action when required.
- Evaluation and assessment of emerging technologies and new features of radio communications, such as encryption and data transfer, to determine the benefits they offer against increased cost and complexity.
- Ensuring that the communications capability provided by HF and VHF radio is consistent with SAR organisations’ health and safety policies.

The complete, populated framework is presented below:

Principles	Elements						
	Equipment and network	Workforce	Local coordination	Incident management	Stakeholder management	Protocols	Environmental management
Reliable - 100% reliable, replicable communications when/wherever required	<ul style="list-style-type: none"> Equipment is regularly maintained and serviced All radios configured with a consistent national channel naming convention 	<ul style="list-style-type: none"> AREC integral part of response team Each search team is equipped with at least 2 VHF radios One HF radio per search team 	<ul style="list-style-type: none"> Dependable voice connections between SAR HQ and individual search teams 	<ul style="list-style-type: none"> Voice connection to local coordination /search teams, e.g. via telephone interconnect Continual voice recording 	<ul style="list-style-type: none"> Communication channels between SAR teams and other SAR support groups, e.g. Police, DOC, Fire, SLSNZ, Coastguard etc. are available when required 	<ul style="list-style-type: none"> Standard radio operating procedures agreed and applied throughout NZ 	<ul style="list-style-type: none"> National equipment maintenance practices and processes provide reliable, functioning equipment at an affordable cost
Usable – Radio equipment can be set up and operated under all search conditions	<ul style="list-style-type: none"> Can be set up and operated by all SAR team personnel 	<ul style="list-style-type: none"> Volunteers and SAR staff trained, competent and confident in using HF/VHF radio equipment 	<ul style="list-style-type: none"> Base stations, repeaters etc. available and accessible when required 	<ul style="list-style-type: none"> Incident Management Centre can talk directly to search teams in situ 	<ul style="list-style-type: none"> Search teams can communicate with other SAR organisations (e.g. rescue helicopter) via radio 	<ul style="list-style-type: none"> Operating procedures are up to date and everyone is regularly trained in their use 	<ul style="list-style-type: none"> Radio equipment is portable, easy to carry and safe to use in all land-based search environments
Available – radio services can be established anywhere on New Zealand's landmass	<ul style="list-style-type: none"> HF and VHF radio infrastructure across NZ landmass e.g. repeaters in place to 	<ul style="list-style-type: none"> Search teams can rely on radio services wherever they operate 	<ul style="list-style-type: none"> AREC personnel available to provide radio connections at all SAROPS events 	<ul style="list-style-type: none"> Police and DOC HF networks providing radio services when required 	<ul style="list-style-type: none"> SAR Agencies' technical working group to lead discussion on current and future radio 	<ul style="list-style-type: none"> National channel allocation, naming and management strategy that applies to all 	<ul style="list-style-type: none"> Permanent repeaters set up in frequent search areas Equipment is maintained to

INTEGRATED RADIO COMMUNICATIONS FRAMEWORK FOR NEW ZEALAND LAND-BASED SEARCH AND RESCUE OPERATIONS

Principles	Elements						
	Equipment and network	Workforce	Local coordination	Incident management	Stakeholder management	Protocols	Environmental management
	support SAR requirements				communication issues and requirements	SAR agencies	a consistent level, e.g. batteries are replaced after a specified period
Effective – radio equipment and services (voice, data etc.) are appropriate to the search environment	<ul style="list-style-type: none"> Provides the full range of connectivity and services required to support SAR activities 	<ul style="list-style-type: none"> Assists SAR teams to function confidently, effectively and safely in all conditions 	<ul style="list-style-type: none"> Continual knowledge of each SAR team’s position and condition 	<ul style="list-style-type: none"> Able to send and receive important search directions and information 	<ul style="list-style-type: none"> Interconnection with other SAR organisation(s) where required to utilise available resources 	<ul style="list-style-type: none"> Clear decision criteria in determining future equipment requirements 	<ul style="list-style-type: none"> Integrated purchasing practices to ensure best product / feature set for lowest cost
Sustainable – integrated, cost effective, environmentally sound radio services supporting SAR health and safety policies	<ul style="list-style-type: none"> Equipment and frequencies confirm with NZ and international radio standards 	<ul style="list-style-type: none"> Each team member is trained and proficient in the use of HF/VHF radio equipment 	<ul style="list-style-type: none"> Enables rapid search team deployment, supports best practice search practices 	<ul style="list-style-type: none"> Supports use of incident management software, e.g. SARTrack 	<ul style="list-style-type: none"> Safe working environment encourages ongoing volunteer involvement in SAR groups 	<ul style="list-style-type: none"> Radio availability, management and usage supports relevant Health and Safety policies Alignment with other national networks, e.g. WGRN 	<ul style="list-style-type: none"> Existing HF/VHF capability supported and maintained into the future

5 Responses from key stakeholders

Part of the information gathering process for the report involved seeking input from a number of SAR agencies and stakeholders via an on-line survey. Eighteen responses were received to a list of questions concerning the types of equipment used by a particular organisation; whether a specific communications strategy had been developed; shortcomings of existing radio networks, equipment and practices; and current and future radio communications requirements.

The survey results indicated a wide range of HF and VHF capabilities for each of the SAR agencies and other agencies that could be engaged to share equipment and repeater frequencies and coverage. In particular the various Regional Council/Territorial Local Authority Civil Defence management groups who responded demonstrate extensive radio infrastructure within their particular areas. They have existing relationships with their local AREC organisations and have expressed a willingness to work more closely with SAR organisations.

The response from RCCNZ confirmed that they don't own or manage any land based radio networks but very often interact with organisations that do. Due to the number of different networks and differing coverage, communication with SAR assets can be very complicated and on occasion directly hampering the SAR response. This may be exacerbated in the future as more SAR operations involve a response to personal location devices (PLB) which are managed and coordinated by RCCNZ.

Surf Lifesaving New Zealand are undertaking an ambitious digitisation programme to replace its extensive VHF LMR (EE Band) repeater network with fixed links. This network is a mix of analogue and DMR tier 2 conventional. However, by 2020 in excess of 80% of their network will be Digital Mobile Radio (DMR). SLSNZ by 2020 will have approximately 45 repeaters throughout the country broken down in multiple micro networks. This may provide another avenue for SAR agencies to utilise an expanded digital radio coverage footprint.

The Department of Conservation's fixed HF base radio network is declining in number as their use of satellite telephones has increased. There are 10 base stations remaining, along with over 100 HF handheld radio sets that are no longer being used.

The data collected by the survey is shown in Table 2, overleaf:

TABLE 2: Communications Equipment available to SAR agencies

Stakeholder	Forms of Radio Communications used								
	VHF/FM Handheld Portable radio	HF handheld portable radio	Back pack radio	Vehicle mounted radio	Xportable base radio	Fixed base radio	Xportable VHF repeaters	Fixed repeaters	DOC fixed repeaters
LandSAR	✓	✗	✓	✓	✓	✓	✓	✓	✓
AREC ³	✓	✓/✗	✗	✓	✓	✓	✓	✓	✓
NZ Police	✓	✓	✓	✓	✓	✓	✓	✓	
RCCNZ	✗ ⁴	✗	✗	✗	✗	✗	✗	✗	✗
DOC	✓	✓	✗	✓	✓	✓	✓	✗	✓
SLSNZ	✓	✗	✗	✓	✓	✓	✗	✓	✗
Stakeholder	Forms of Radio Communications used								
	Fixed HF base radios	Police digital trunk radio networks	Common (liaison) VHF FM simplex	Cellular / Satellite phones	Telepagers	Personal Locator Beacons	Radio access to comms centres	Access to aeronautical VHF/AM freqs.	
LandSAR	✓	✗	✓	✓	✓	✓	✗	✗	
AREC	✓	✗/✓	✓	✓/✗	✗	✓/✗	✓ ⁵	✓	
NZ Police	✓	✓	✓	✓	✓	✓	✓	✓	
RCCNZ	✗	✗	✗	✓	✗	✓	✗ ⁶	✗ ⁷	
DOC	✓	✗	✓	✓	✗	✓	✗	✓	
SLSNZ	✗	✗	✓	✓	✗	✗	✓ ⁸	✗	

³ AREC National and AREC Wellington respectively - AREC Wellington uses the Police digital network to talk with Police in support of land based SAR operations using Police supplied radios.

⁴ Through Marine Network

⁵ Can communicate via VHF/HF to Maritime NZ

⁶ RCCNZ communicates with Police/Fire/Coast Guard etc. by land telephone

⁷ RCCNZ communicates with aircraft via Airways

⁸ SLSNZ has current interoperability with Coast Guard; discussing interoperability with NZ Police

TABLE 2: Communications Equipment available to SAR agencies (continued)

Stakeholder	Forms of Radio Communications used								
	VHF/FM Handheld Portable radio	HF handheld portable radio	Back pack radio	Vehicle mounted radio	Xportable base radio	Fixed base radio	Xportable VHF repeaters	Fixed repeaters	DOC fixed repeaters
Emerg. Heli ⁹	x ¹⁰	x	x	✓	x/✓	x/✓	x/✓	x	x
Coastguard	✓	✓	x	x	x	✓	x	✓	x
NZDF	✓	✓	✓	✓	✓	✓	✓	✓	x
NZ Fire Serv	✓	✓	x	✓	✓	x	✓	✓	x
Ambulance	✓ ¹¹	x	x	✓	✓	x	✓	x	x
MNZ/MOC	x	x	x	x	x	✓	x	✓	x
CD/TLAs	✓	✓/x/x/x	✓/x/x/x	✓	✓	✓	✓	✓	x
Stakeholder	Forms of Radio Communications used								
	Fixed HF base radios	Police digital trunk radio networks	Common (liaison) VHF FM simplex	Cellular / Satellite phones	Telepagers	Personal Locator Beacons	Radio access to comms centres	Access to aeronautical VHF/AM freq.	
Emerg. Heli	x/✓	x	✓	✓	✓/x	✓	✓	✓	
Coastguard	✓	x	✓	✓	x	✓	✓	x	
NZDF	✓	x	✓	✓	x	✓	x	✓	
NZ Fire Serv	✓	x	✓	x	x	x	✓	x	
Ambulance	x	x	✓	✓	✓	x	✓	x	
MNZ/MOC	✓	x	x	x	x	x	x	x	
TLAs ¹²	✓/✓/✓/✓/✓	/x/x/x/✓	✓	✓	x	x	✓	x/✓/✓/✓	

⁹ Northland Emergency Services Trust and Southern Lakes Helicopters Ltd respectively

¹⁰ Hard mounted in helicopter only

¹¹ ESB band channels licensed for ambulance operation only, plus ES liaison channels

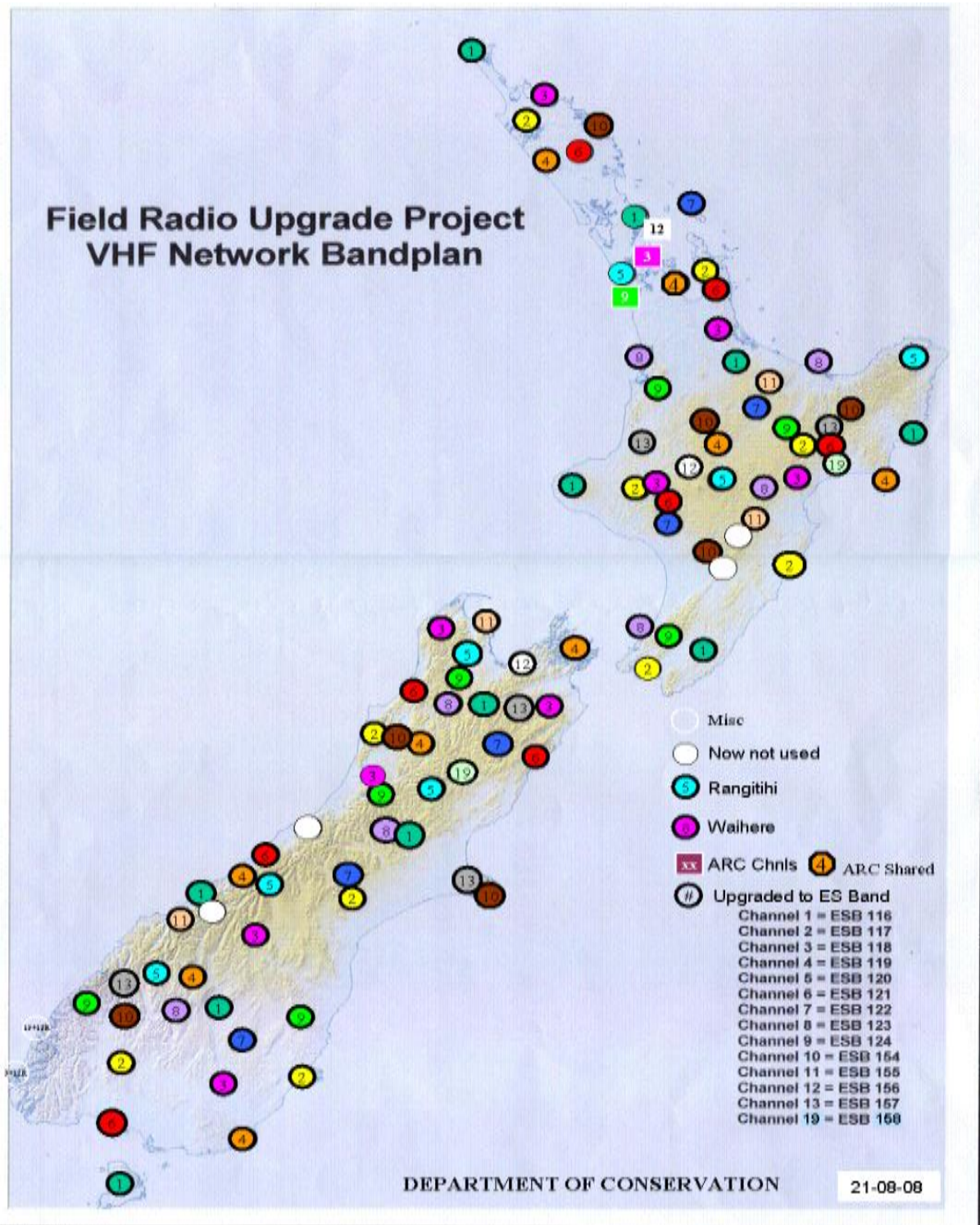
¹² Response from Hawkes Bay CD, Auckland Council CDEM, Waikato Regional Council CDEM and Wellington EMO respectively

Appendix 1: HF radio stations in NZ accessible to the Police

Please note that the New Plymouth station no longer exists. There is a new HF radio station at the Gisborne Police station.

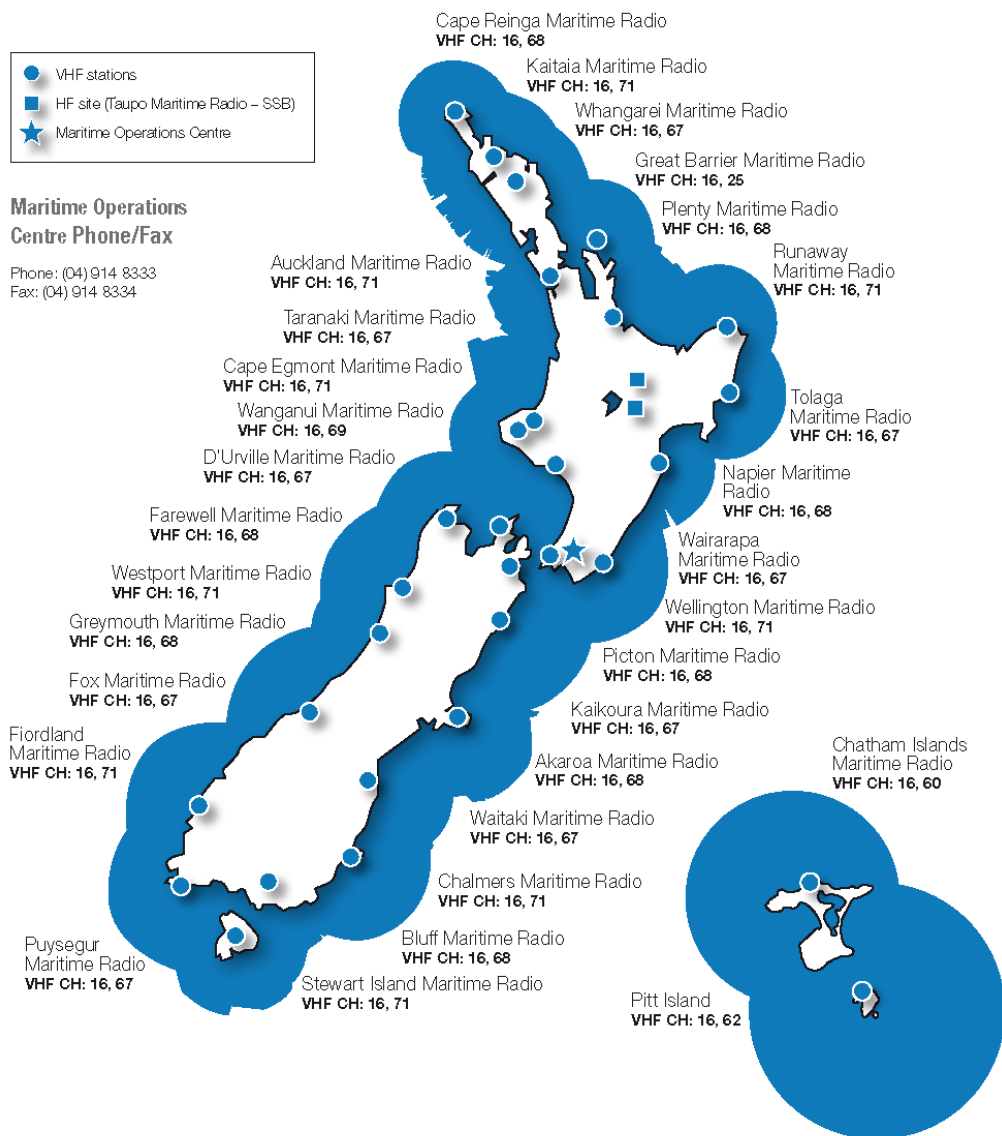


Appendix 2: NZ DOC VHF radio network



Appendix 3: Marine VHF Coverage

Maritime Radio VHF coverage



Note: gaps in coverage may exist within the areas shown, due to terrain 'shadows' (which can occur under cliffs close to the shore or in bays and fiords) and occasional system maintenance.