UAV for Emergency Response Operations

Emergency Response verses non-emergency operations

There are considerable differences between UAV operations for emergency response and that of non-emergency operations. Indeed, the fundamental premise that determines methodology, aircraft selection, payload selection, data analysis, data outputs and communications are all based on distinctly different criteria. Non-emergency operations closely mimic commercial operations and the focus is primarily “how can we get the highest quality data and what tools will best provide this?”, whilst the focus of an emergency operation is “what is the minimum threshold level of actionable data and how do we effectively communicate this?”

Emergency Response operations aim to attain and deliver actionable data, information that is of sufficient quality and quantity to make decisions within the hours, days and weeks immediately following a disaster event. Speed is a considerable element. A common saying in Emergency Response organisations is “after 72 hours it is Disaster Recovery not Emergency Response”.

Following an Emergency Event, non-emergency operations focus on the longer-term strategy of recovery rather than urgent response requirements. These are generally carried out several weeks and even months following an event, usually in conditions where there is some stabilisation of logistical services including transportation and communication connectivity. Even in situations where there will be some vestiges of the challenges created by a disaster event, the operational environment is likely to be less demanding with different requirements in equipment, data and methodology. The aim will be large scale data collection, the more the better, to allow detailed review of every element relevant to the recovery phase and allow identification of any aspect that was missed in the rapid assessment process.

Of the two types of operations it is the Emergency Response missions which are the least tested and therefore least understood. They also offer the most challenging and unpredictable situations.

Whilst similar types of UAV equipment have been seen used in both situations, this is mainly because there are limited dedicated emergency system UAV platforms rather than that these existing platforms are well suited to both types of operations. In most cases the commonality of equipment is largely due to commercial enterprises focusing on non-emergency operations, such as survey and photography, which means that the responder groups, made up largely of commercial companies or teams equipped by commercial companies, simply take aircraft best suited to these types of operations and attempt to apply them to an emergency when it arises.

This also applies to the type of data capture equipment and methodology used on board the UAV. For example LiDAR is a very effective tool for high definition analysis but its cost, availability, weather ability and durability make it of questionable value in a fast moving situation where large amounts of more basic data sets, captured by more robust processes, may have far greater value in enabling a rapid response by decision makers. In a non-emergency situation the applicability of this equipment and methodology is likely to change and the tools will become of considerably more value but these are vastly different scenarios and operating environments.

This is not to say that such specialist equipment is not a highly valuable asset in specific situations. Indeed where very specific requirements emerge, like the need for close study of key infrastructure such as bridges and dams, where there is immediate danger and a critical need for high definition analysis, these tools can be of considerable utility. But these are considerations for a specialist response that needs to be merged into the methodology of the overall response. Initially the primary requirement for Command Centres is simply “what is the situation now?” and that requires basic actionable data in the vast majority of circumstances.

Beyond equipment considerations there is an even stronger dissimilarity in organisational and logistical arrangements between emergency and non-emergency situations. There are fundamental differences in how field operations are actually conducted. For example, in a non-emergency operation there is no pressure to have data processing and analysis immediately available. There is often easy access to a variety of communication systems to disseminate the data, with access via cloud-based servers for remote analysis from almost anywhere in the world.

Experience has shown us that during emergency events conditions just aren't like that. Depending on the level of damage resulting from an event, there may be very little, if any, communication infrastructure available. Where there are limited connectivity options then the obvious resort is to satellite communications but these are still currently a very expensive option for high data through-puts and this has considerable implications for small nations with limited resources. In the Pacific, with disparate island groups, this issue is exasperated to an even greater degree. It may be that the nature of the event itself may impose conditions where satellite communications just isn't possible.

Although rarely considered, there is also a need for accurately identifying existing regulatory issues and air traffic control. Air traffic does not just stop during an emergency, indeed experience has shown that air traffic can considerably increase adding heightened need for respecting shared regulatory codes for operations.

For all nations or organisations involved in Emergency Response there is a pressing need for training to be considered, even for teams and organisations that are not directly participating in UAV operations. This is because, to maximise the outcomes that such systems can offer the third-party groups must understand the potential applications and limitations of these systems so that they can work with those conducting the UAV operations. In addition to this we can also see that other emergency responder services input would be of substantial benefit, advising the core UAV Field Team on priority targets, environmental and operational considerations. The relationship is symbiotic, and the healthy flow of cooperation and coordination vastly increases the potential of best outcomes for all groups involved in the Emergency Response.

From a practical point of view the operational dissimilarity between emergency and non-emergency operations has many implications. For example, it is our conviction that the data capture and analysis capability must be part of the core UAV Field Team, with equal operational value as the data collection (UAV) team. The simple fact is that the collected data is of very little use if it cannot be processed and analysed into usable information. Delays in achieving this usable information or isolation of this data makes the data collection operation of limited value for decisions enabling rapid response. For this reason, we would also highlight the importance of infrastructure independent communication.

Saving time and maximising resources to achieve the most efficient and effective outcome is the primary goal.

These are the three core elements necessary to an Emergency Response capability,
1/ Data Collection
2/ Processing and Analysis
3/ Information Dissemination.
Therefore, our recommendation for an effective Emergency Response UAV Field Team has all three essential elements. In a Emergency Response UAV Field Team all three elements hold equal value.

Key Points

1/ Communication: Experience has proven that the ability to carry out infrastructure independent communications is a key to all facets of Disaster Response operations. The critical element of infrastructure independence not only applies to the capture of data but also the evaluation and dissemination of that data to all relevant key organisations involved in a Disaster Response.

Several key levels of information connectivity are:

a) Aircraft to UAV Field Team, including live streaming of near real-time video or sequential still photography: This is particularly important for long range operations where situational awareness and speed of response are crucial but is also true of mid-range and even short range operations.

b) UAV Field Team to Command Centre: Ideally the field team can operate in close proximity to the Command Centre but in many cases these operations may be in remote locations and the information, either raw data or compiled results, need to be communicated to those in decision making positions. The distance of a single mountain, river or island is sufficient to isolate decision makers from the information required. The more potential steps in the information chain, the greater the risk of delays. For example, if the data is stored on-board the aircraft rather than relayed to a group system and the UAV is compromised, forced to land or lost, what ensues is a major loss of intelligence data. Looking at single, large format aircraft, it is important to note what logistical requirements need to be made to support their operation as well as a plan B to allow the relay of this information should this asset be compromised. There is a growing and logical move towards SWARM methodology as an effective way to minimise the “siloed data” threat of reliance on single platform data collection. Either way, the importance of lowering the risk of information loss by transference of data during flight operations is critical.

c) Command Centre and Support Agencies: For the data to be of any use the Command Centre must be able to utilise this information by communicating it to those implementing the tasks in the field. This includes a wide range of support responder agencies as well as the UAV Field Teams collecting the data. In order to achieve the maximum response results, attaining the best coordination of resources, this information sharing needs to be on local, national and international levels.

Recommendation: To highlight the importance of this issue, it is our evaluation that infrastructure communication is *the* most important aspect of Emergency Response capability. It is more important than all other aspects of data collection simply because that information is useless to the decision makers if it cannot be communicated. We have discussed this issue with a range of key Emergency Response agencies and without dissent ion they all recognise the key aspect of infrastructure independent communication.

2/ Field Team Transportation: As highlighted in X-craft's post mission review of Cyclone Pam operations in Vanuatu, of all aspects in that mission perhaps the most costly in productivity was the lack of appropriate transportation. For a Field Team, simply getting to the operational locations are the biggest single limiting factor of productivity. X-craft estimated that when operating in Vanuatu post cyclone Pam between 40% to 50% of its potential productivity was impaired by this issue alone. We can start to get a perspective of the relevance of this when we consider whether, in comparing aircraft systems, if an aircraft is 10% to 20% more efficient than another aircraft in data collection, this has less than half the potential productivity impact than achieving reliable transportation of the UAV Field Teams. Quite simply, recognising transportation of UAV Field Teams as a major contributing factor to productivity will give greater gains than any other operational element.

Aircraft that offer easy transport-ability: There is little doubt that small, highly mobile aircraft have benefit for rapid response capability. This is particularly true for UAV Field Teams attempting to access remote areas and particularly relevant to operations that can utilise backpack-able systems for when UAV Field Teams are required to travel by foot. But this capability must be prefaced with caution. The problem is that, although useful, these types of operations have inherent limitations already. For example, how do you recharge batteries without electricity or a generator, how do you eat, where do you sleep, how are you protected from the weather? It is likely that a far more important factor in mobility gains is the availability and type of transport provided to the UAV Field Teams.

Recommendation: For UAV Field Teams transportation is an element of primary importance in any Emergency Response mission therefore the framework and practical implementation of making this resource available must be considered in longer term planning. To this end, for Field Team deployment, a range of options should be considered including a) *standing priority arrangements* with transport companies *within* the locations intended for operations. b) *standing priority arrangements* of delivery of transportation from *outside* any operational zone (perhaps via military transport or civilian cargo aircraft). What is needed is the establishment of a plan that offers a practical framework for a solution to this problem *before* Emergency Response operations are required.

3/ Mobile launching and landing platforms, airborne UAV delivery. As well as delivery platforms, should be seen as priority ways of offering an alternative form of deployment for UAV Field Teams and their equipment rather than just ground based transportation. Manned aircraft and sea vessels both provide considerable opportunity as centres of operations for UAV Field Teams. This is particularly relevant to island nations as it can free them from the constraints of environmental damage on the land that may limit potential mobility. To trial this may involve testing a range of sea vessels to evaluate their suitability as a operational platform.

There is also the air-drop deployment of aircraft which could be brought into an area by a manned “mother” aircraft. UAV can be deployed, with multiple aircraft controlled from the manned “mother” aircraft where flight control centres are operated by the UAV Field Teams. This has huge potential in information gathering efficiency as well as vastly increased communications relay capability.

In our experience we have identified that ground proofing of data is a major benefit to any information gathering operation.

Recommendation: The targeted delivery of an emergency communication device can greatly assist this by connecting with isolated people, villages and support agencies. In addition, rapid delivery of even a limited range of medical supplies could offer lifesaving capability.

4/ Tracking and Identification of life forms: There is a growing suite of small and increasingly inexpensive sensors that can have major benefits on Emergency Response and Disaster Recovery operations. For example, using MSI (Multi-Spectral Imagery) sensors for identifying plant health. Such sensor technology is highly beneficial as food security is a primary consideration in both short term and long-term Emergency Relief Operations. The health of agriculture is essential in this regard and we have also heard anecdotal concerns about the dispersion and loss of livestock. In addition to this, humans are also at risk of being dispersed or isolated during and after an emergency event.

Recommendation: Similar methods of Search & Rescue methodology can achieve results in tracking and identifying most life forms. The use of IR sensors should be considered a standard payload option with the specific objective of tacking and identifying all relevant lifeforms, both human and livestock.

5/ A Focus on *Appropriate Data* rather than *Maximum Data* : In non-emergency operations there is a focus on maximum data. There are obvious benefits for this but it entails a considerable chain of consequences, particularly around data processing times, communication capability and logistical support requirements. The trade-offs inherent in these consequences are more worthwhile the longer time passes after the Disaster Event, where communications and logistical support are less tenuous. There are relevant periods post disaster where the environment becomes more conducive to this type of task. We can arguably call these non-emergency operations in at least they are less urgent in nature.

There is an obvious focus on attaining high-definition 3D terrain models and an interest in LiDAR outputs for these types of operations. Whilst the data outcomes of these operations are very useful in evaluating and detailing specific requirements, they are also very time hungry in processing requirements and logistically demanding aspects of UAV work.

Recommendation: The aim of Emergency Response Capability is "actionable data". This means not attempting to capture and process anything beyond the essentials required to achieve that objective. In some cases simply a live video feed may be sufficient to achieving accurate situation awareness and a suitable response. In other cases a rapid 2D orthomosaic captured by an initial aircraft deployment will enable analysts to identify specific areas of interest, then deploying a second aircraft to carry out a site specific survey with advanced sensors, will be quicker than attaining a single 3D model of a larger area.

3D models are built up from 2D photo orthomosaic point clouds or LiDAR. Once orthomosaics are captured these can be used as an "instant" situational map. By far the largest amount of time to utilise these images beyond 2D reference is in the processing of this information into 3D models. In many cases this will include substantial amounts of non-important data. A faster way to approach this is to conduct what is known as "spot modelling", which allows creating 3D models from selected regions from a 2D orthomosaic, rather than process all data captured into a 3D model. This allows a focus only on areas of interest rather than all images captured, saving considerable time.

6/ Aircraft Design and Construction: We must be very cautious when an evaluating airborne system's relevance to any specific operation or range of mission parameters. There are a number of important elements that are not always obvious and many important issues that need consideration.

Any aircraft platform must be considered in the light of the mission requirements. For example, we just ask ourselves, if the mission requires a range of data collection options, and therefore a range of payload capability, is the aircraft able to accommodate this? If not, then either more than one aircraft will be required for any specific mission which has multiple data targets or it may be better to focus on having one aircraft that can carry out a wider range of operational capabilities, i.e. multiple payload capability. An alternate aircraft platform that can offer a variety of payload options may be slightly heavier and potentially slower to capture the required data but may remove the necessity of needing multiple aircraft for a range of operations. This is indeed a balancing act but one that can only be thoroughly considered if aware of all the design and construction elements involved. These are often obscured and not always able to be revealed by a short or limited study. Certainly, there is considerable difference between Emergency Response and Non-Emergency response aircraft requirements.

Recommendation: A checklist of mission requirements should be evaluated and established, ranging from essential, to beneficial and non-essential elements. This could be formatted as a *requirement matrix* with mission elements and aircraft elements compared. Perhaps the issue can be considered with establishing what we understand to be the requirement elements of any specific task and then refine the most suitable platform via a requirement matrix. Basically starting with the operational essentials first rather than aircraft performance first. If considered from this aspect we may consider the lessons of the *Tortoise and the Hare* analogy. It would also consider the relevance of platform to mission requirements in a more holistic way and refine the aircraft requirements beyond the aircraft platforms currently available.

8/ Immediate Response: Although information gathering is the core activity of the first phase of UAV Field Team activity, the ability to respond has high impact potential. For example, delivering communications capability can gather information from and relay information to those on the ground, whether they be civilians or Emergency Response Ground Teams. The rapid delivery of medical supplies is another obvious live saving capability.

Recommendation: Delivery capability is of such potential that a separate UAV Field Team group should be established as an Emergency Responders Team.

9/ Methodology: An essential factor in all Emergency Response efficiency and effectiveness is *the way* these operations are carried out, their operational *methodology.* This is something that is not limited to just the aircraft or ways of capturing and processing the information but rather the *big picture,* which includes a variety of non-UAV activities. Perhaps this is best illustrated by our concern about non-infrastructure communication capability, an element which includes information sharing of the data captured by UAV's but also includes elements beyond the actual activities of the Field Team UAV operations. This is recognition that UAV data collection, analysis and dissemination is one, albeit crucial, element in the total Emergency Response operation.

Recommendation: Utilising UAV in Emergency Response considers the operation with direct relevance to the overall Emergency Response methodology. The closer the synergy between the requirements, operational systems and methodology of the overall Emergency Relief operation, the greater the efficiency and efficacy of the UAV element as a tool in that system.

Approach and Methodology

Command and Control : Due to data latency issues for long range operations, it is essential to note that for near real-time control of the aircraft it is important that the Field Team control is as close as possible to the aircraft. This can be either island based, ship based or aircraft based. This is why we recommend that the long range aircraft operates in a radius rather than a direct line of distance. This why we recommend operations from Vava'u itself, encompassing the various islands of that group.

Data stream : As well as rapid control capability of the aircraft, the Field Team control will have near real time video and orthomosaic data streamed from the aircraft to their system. This information will then be streamed from the ground based Field Team system to satellite and down to the Control Centre at Tongatapu. In doing the data transfer in this way the massive amounts of raw data can be collected at the Field Team control without satellite connectivity whilst a lower resolution stream can be made available to Tongatapu command centre. This saves considerable cost due to satellite data charges. When areas of interest are encountered the Tongatapu command centre can ask for high resolution feed of that particular zone. The Field Team can then enable the higher resolution in near-real-time on-call. The Field Team is also collating the 2D orthomosaic which it can then supply in a similar fashion, at higher resolution zone specific packages.

Beyond Line Of Sight (BLOS) operations can be supplied built is essential to recognise the consequences of this. Without dedicated military satellite connectivity there will be issues such as,

1/ Command and control latency means that the pilot cannot react to any on-board issues that could threaten the aircraft and payload.
2/ Command and control latency means that the pilot cannot react to situations on the ground as rapidly and therefore could cause delays in responding to points of interest.
3/ The cost of streaming HD data through a satellite platform is extremely expensive and prohibitive over such a long flight time.
4/ The data is more secure and not susceptible to satellite dropouts or disruption
5/ Selecting points of interest from low resolution data is very difficult and susceptible to oversight of important observations therefore it is important that at the first stage of the data feed HD data is provided for analysis.

Data Targets: The primary aim of Emergency Response operations for UAV Field Teams is to attain “actionable data”. In order to achieve this aim the data collected will be focused on the minimum data that ensures sufficient quality and quantity to give high grade information to the Command Centre. As the recommended Field Team is highly self-sufficient, its operation will offer actionable data in a processed, analysed format, ready for the decision makers. Following the delivery of this information, decisions will be made as to what, if any, further advanced survey operations are carried out.

The Phased Response: This methodology is a “phased response” approach. The objective is to provide information on an “as needed” basis rather than in-depth analysis of the total area of all operational zones. In this method a “scout“ aircraft is used to give immediate intelligence and refine data targets. This information is relayed in near real-time to the Command Centre to allow them to make decisions on what further actions, if any, are required. Following this, with defined target/mission objectives, the second phase is action-ed using the most appropriate platform and sensors for the specific objective. Even in the more advanced survey operations there will be a considered approach to obtain only relevant information. An example of this is to conduct “spot modelling” a process whereby an optical orthomosaic is captured but rather than creating a full 3D model of the total area, a series of specific target areas of interest are identified from the orthomosaic and spot 3D models are created. This saves considerable processing time. A fixed wing platform will provide communication relay capability where required.

Expansion of Actionable Data: There will be tasks where “actionable data” will actually require a high degree of accuracy, particularly GPS positioning and high-definition imagery. For example, if requiring a survey of a dam or bridge that may be suspected of structural damage. In this case GCP's will need to be established prior to flight operations. There are tests underway to research air-deploy-able GCPS but the solution is not currently available so in the short term this still involves ground personnel to deploy them. In many other cases “actionable data” may only require a GPS accuracy of a couple of metres. In this scenario the time required to set up GCP's can be removed from the data capture and processing operations, greatly increasing the speed of information dissemination.

Exceptions to the core UAV Field Team : Long range UAV operations are an exception to the standard Field Team methodology due to the differing requirements of large fixed wing aircraft operations. That is not to say that the Field team alters its core structure or basic operational methodology rather this core team is added to by an additional team who specialise in larger scale, longer range deployments. Therefore several additional Field Team members would be brought into the core team, along with specialised long range platforms, to supplement the additional requirements. Due to the dispersed nature of the the Pacific Island states, we believe there are considerable merits in conducting both long range operations from a fixed base and missions from a mobile platform, particularly ship based and aircraft platforms.

Consideration for technological evolution in Future trials: Due to the rapidly changing nature of UAV technology there are several UAV deployment technologies that are rapidly maturing and will be instrumental in the near future for further trials :
1/ Air-deliverable UAV solutions, where multiple small UAV are deployed from larger aircraft.
2/ SWARM methodology, where multiple, highly autonomous aircraft are deployed for any specific event to cover large areas in a single operation rather than multiple operations of single platforms.
3/ Sea based operations, where flight operations occur from all types of available ships.

A Work Plan for Emergency Response Trials

Emergency Response: An ideal operational plan for Emergency Response trials would be to simulate an actual emergency response operation as closely as practicable. This is because data and operational methodology that does not do this will not reflect the real-world challenges associated with this type of event. There is already adequate existing knowledge about non-emergency operations without needing to be included in these trials. What is of interest is how a Field Team Operation, using UAVs, can achieve the required data outputs. Of course, one of the key questions that should be posed from the outset is, "what are the required data outputs" that are most relevant to achieve actionable information for an Emergency Event Response ? We would therefore begin the process with involving a range of potential stakeholders, those who conduct the Emergency Response operations, to help clarify what is the most relevant data to achieve actionable information to assist an Emergency Event Response.

Pre Mission:

1/ A meeting with all potential stake holders involved in Emergency Response in the Pacific Island Nations. This would include the participation of services active during such an event in order to offer consultation on objectives and interoperability.

2/ A simulated Command Centre be established. If required X-craft can establish this with a communications person and trial coordinator or working directly with host nations existing Command Centre as a simulation exercise. This can either be staffed with host nation personnel, SPC personnel, or provided by an X-craft consortium. This could also be a amalgam of all parties with a vested interest.

3/ A briefing prior to the commencement of the mission should be held to determine what types of data and formats of data will be acceptable as actionable data. A communication format will also be established between the Field Team and the Command Centre.

Operations:

1/ A core UAV Field Team would be deployed into Tonga and provided with a suitable vehicle for transporting the team and equipment. This should also include logistical necessities for infrastructure operations such as power generation capability, water, food, communications and camping equipment.

2/ Upon arrival the UAV Field Team will be informed of the sequence required to conduct operations in multiple designated areas. They will be given the coordinates, existing intelligence information on the operational zones.

3/ Once the UAV Field Team has reached these operational zones a reconnaissance flight operation will be carried out over the designated zone of interest given as specific coordinates by the Command Centre.

4/ Upon receiving the reconnaissance information the UAV Field Team will relay this information to the Command centre. The Command Centre will respond with a request for specific tasks to be carried out. This process would be repeated in each of the operational zones. The data types and formats will conform to those determined in the pre-mission briefing but the tasks will be requested only as updated orders to the UAV Field Team.

In some circumstances it should be trailed that the Command Centre cannot be reached and the UAV Field Team will need to use its own reconnaissance information to determine its own follow-up specific tasks to obtain relevant information pertinent to what they perceive as priority targets for "actionable data". This will test the Field Team's grasp of appropriate data considerations.

5/ Each task zone will have different content and objectives that reflect an emergency event. This could be run in conjunction with an independent team setting up the task environment prior to the operations (i.e. have dispersed people that require being found or utilise building, bridges, infrastructure that are already damaged)

6/ The data is to be captured in the most appropriate way, with the most appropriate payload, to enable actionable information, processed on site and transmitted to the Command Centre. This payload selection will be decided during the process of the phased response, i.e. derived from the initial reconnaissance flights and the ensuing consultation between the Field Team and the Command Centre.

7/ Long range operations should involve both fixed location operation for long range fixed wing aircraft and ship-based operations. The initial basis of action being the same, to attain near-real time video link for initial reconnaissance. This may be appropriate enough for actionable data or a further operation may be called upon to carry out further data capture. This may be split into a two-stage operation, with the long-range flight attaining initial intelligence and the ship-based operations to carry out advanced “surgical” data capture.

Data Outputs during operations: There will be a strict focus on achieving the maximum amount of processing and analysis by the Field Team. The Command Centre will be supplied with a precise analysis of the data captured and any specific relevant data following each flight operation.

Video, Still Photographs, Orthomosaic, Multi-spectral Imagery and Infra-red imagery will be captured and stored by the Field Team on HD backup drives throughout the mission. Relevant or edited clips will be transferred to the Command Centre to clarify the analysis achieved by the Field Team. Where possible video will be live streamed back to the Command Centre and, if available, to web-based access for national or international viewing and additional analysis.

Documentation during operations: As is common during any flight operations, all flight data, including flight paths and on-board systems, will be recorded and made part of the stored data for future reference. Also recorded will be flight logs, including any details of the aircraft and equipment as well as environmental conditions relevant to the operations.

This documentation will include real-time flight-path data that allows total recall and playback. This allows both synchronisation with other data, including sensors, and allows a reusable flight-path file if required.

A summary of each task will be provided including both the UAV documentation and the GIS analysis achieved by the Field Team. The Command Centre will provide a report on what information was shared with them for future correlation with the Field Team data.

Documentation post mission: All task documentation will be compiled and the individual task summaries presented. Following a review of these a graphic summary will look to chart the relevant relationships. There will be several graphic summaries to detail a range of relationships such as equipment used, data outcomes achieved, environmental factors influencing operational procedures, speed of achieving the outcomes, clarity of information shared with the Command Centre, usability or action-ability of data provided. The focus of this data will be to detail the utility of the information collected, including the speed of its delivery and accuracy.

A final report will be compiled and a review undertaken by regulatory and operational consultants. This report will summarise the successes and failures that were establish along with recommendations on best practice procedures for future operations.

Organisation and Staffing.

A Core Emergency Response Team

Command Centre
1 x Communications Officer
1 x Project Team Leader

Core UAV Field Team:
Pilot
UAV Systems Manager
Data Processing and Logistical Support
Data Analysis and Structuring to Actionable Information
Communications Officer

Extended UAV Field Team (Long range Operations)
Pilot
Systems Manager
Director of Operations