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13. SHIP-BASED AIRCRAFT OPERATIONS

13.0 INTRODUCTION

Marine science researchers have employed aircraft as productive platforms for supporting ocean observations and research since the middle of the 20th Century. More recently, the emergence of unmanned aircraft – both remotely piloted and autonomous – holds significant promise as a means to significantly expand the visual and electromagnetic horizon of research ships, providing cost-effective employment of off-board sensors for conducting marine science research missions. In the near future, the inventory of oceanographic aircraft used by the UNOLS community will likely change, but the concerns for safely embarking and utilizing such assets on board or in conjunction with oceanographic research ships will remain. The terms “Unmanned-Air Vehicles (UAVs)” and “Unmanned Aerial Systems (UAS)” are used interchangeably throughout this chapter. The more general terms “aircraft” and “platform” and “vehicle” may refer to manned and/or unmanned aircraft, within the context whereby these terms are utilized.

Safety, both for the personnel embarked aboard a manned research aircraft, and for those aboard the supporting ship (both for manned and unmanned aircraft), is paramount in establishing the operating procedures under which oceanographic aviation platforms are employed in science research missions. Over the years, aircraft operating institutions and Federal agencies such as NOAA, the Navy and the USCG have each developed checklists, personnel training syllabi, testing procedures, maintenance intervals, and safety reviews. Conscientious operators likewise will keep pace with advances in material sciences, air platform design, operational envelopes, metallurgy, composites, sensor systems, aircraft handling, launch and recovery systems, embarked electronics, and science data processing and they will continually seek to improve these systems in their relevance and utility for the science users, in training of operational personnel, and in overall safety.

An embarked aerial support system consists of three major components: the aviation vehicle, the surface ship platform, and the on-board system that encompasses launch and recovery and handling the aircraft on deck. A focus on the essential synergy of these three elements can provide an effective and safe tool for marine science research and exploration, and for the personnel supporting this endeavor. Common Certifying agencies in the U.S. are the Federal Aviation Administration, the U.S. Navy NAVSEA, and the U. S. Coast Guard.

13.1 REFERENCES

- USN NATOPS

- USCG (ref. Document here)
- NOAA (ref. Document here)

13.2 REQUIRED BY REGULATION FOR ALL VESSELS

Regulations based on type and certification of aircraft and regulatory status of vessel.

13.3 REQUIRED REGULATIONS FOR CERTAIN VESSELS

13.3.1 INSPECTED VESSELS

None.

13.3.2 CLASSED VESSELS

None.

13.3.3 SOLAS VESSELS

None.
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13.3.4 UNINSPECTED VESSELS

None.

13.3.5 OTHER REGULATIONS

None.

13.4 REQUIRED STANDARDS UNDER RVSS

13.4.1 UNOLS AIRCRAFT OPERATIONS SAFETY STANDARDS

Any UNOLS vessel or vessel chartered by a UNOLS institution in accordance with Chapter 18 of these standards will adhere to the UNOLS Aircraft Operations Safety Standards when conducting any operations involving aircraft designed to carry human occupants, or, if unmanned, to be launched from and recovered aboard UNOLS vessels.

Aircraft platforms must meet all applicable inspection or certification standards applicable, and be currently certified as required by such bodies recognized for that purpose within established regulatory compliance regimes.

13.4.2 AIRCRAFT-CAPABLE OCEANOGRAPHIC SHIP

The vessel must have the ability to conduct two-way communications with the aircraft at the ranges and altitudes throughout the designed operating envelope of the air vehicle in whatever sea state or atmospheric weather conditions within which operations are to be conducted.

Typically, this will include line-of-sight VHF/UHF radio telemetry communications, but relay between aircraft and satellite communications systems may be utilized for over-the-horizon connectivity. A Loss-of-Communication Procedure must be provided. The aircraft-operating ship must have a means for electronic tracking of the position and altitude of the aircraft. This may be accomplished by means of ship's air-search radar, ADS-B or a similar self-reporting system, or such future technologies as may become available. Antennas for tracking and communications systems, both on the surface ship and on the aircraft, must be mounted so that there are no blocked azimuth angles, and so that the propagation covers maximum horizontal distances and altitudes expected to be encountered under both normal and emergency operational scenarios. Personnel assigned to operation of the tracking/communications equipment on the ship must be provided with proper training, spare parts, and technical support. The importance of training cannot be over-emphasized. Please see HOV Safety Standards Chapter 7 and 12 for cross-reference.

The surface support ship must be able to determine, with precision and certainty, the type of airspace in which the aircraft will be operating, and all applicable regulations pertinent to that airspace. Sufficient spares, backup systems and technical support of essential components must be provided.

Rescue assets and outside assistance for a ditched manned-aircraft may, depending upon operating area and environmental conditions, be days away. The surface support ship must be equipped with, and prepared for, a self-rescue capability. This may consist of a second aircraft, along with a ROV system, and a rescue boat. The self-rescue system must be operational over the distances and in the conditions in which the aircraft is capable of operating. Realistic drills and exercises, simulating an aircraft rescue scenario shall be held at regular intervals, no less than once a year, and the results must be documented to assure the integrity of the rescue equipment and to familiarize the personnel on the surface ship and the aircraft operators with its use. These may include tabletop exercises or comprehensive reviews of safety or rescue plans.

In the event of ditching a manned aircraft, life support for at least 72 hours must be available in the aircraft (i.e. life rafts, immersion suits, emergency signaling equipment, water and food).

13.4.3 CHAIN-OF-COMMAND DURING AIRCRAFT OPERATIONS

As per maritime law and tradition, the Master retains responsibility for and authority over all operations conducted aboard the ship, including the deployment of any off-board vehicles employed by the vessel and its embarked personnel. The Aviation Component Leader (or other appropriate official title) is responsible for and has authority over the air vehicle and personnel embarked aboard the ship for its operation and maintenance. The designated aircraft (whether manned or remotely-operated) pilot commands his or her vehicle and has responsibility for and authority over its safe operation. The Chief Scientist, as described elsewhere in this document, is in charge of the mission. Unless accomplishment of the expedition plan is unsafe or illegal, the Master and other key individuals responsible for oceanographic aircraft operations should make every attempt to facilitate science needs. Four persons have launch veto authority. The Master, the Aviation Component Leader, the aircraft pilot, or the Chief Scientist can make a "no-go" decision. (On occasion, the aircraft pilot may also fill the role of Aviation Component Leader.) The others may not outvote or over-ride such a call. A decision to proceed with an aircraft launch should be a consensus decision of these key leadership personnel, but it must be understood that a majority cannot overrule a "hold" or "no go" determination by any one of these key personnel. Similarly, a decision to terminate a flight early and to recover the aircraft may become necessary due to a change in the weather, mechanical issues on the aircraft or the research ship, conflicting traffic (airborne or on the surface), or personnel needs. Again, any one of the key leadership personnel identified in the preceding paragraph can order an early termination of the flight. The final say on the actual timing of the aircraft recovery (unless there is a situation requiring the aircraft to make an emergency descent) is routinely deferred to the ship's Master who will take into account actual surface conditions and the position of the ship with respect to the aircraft, maneuvering the ship as required for the recovery procedure.

13.4.4 SHIP PROCEDURES WHILE OPERATING AIRCRAFT

Prior to the commencement of aircraft launch procedures, the following steps must be taken: (Operators will define specific step-by-step checklists.)
• Assessment of weather, sea-state, and visibility, forecast out to the anticipated end time of the flight and recovery plus long-range forecasts for the life support capabilities of a manned aircraft in emergency conditions.
• Assessment of the operating area including winds, sea-conditions, ceiling and restrictions to visibility, and the possible presence of other hazards that create an undue risk of damage to or loss of the aircraft.
• Assessment of air and surface traffic, especially in areas of heavy maritime or airborne activity.
• Establishment of radio and vehicle tracking protocol, selection of frequencies and intervals for communications with the aircraft, and announcements on the radio guard channels to provide warnings for other aircraft and/or shipping.
• Conducting planning meetings, as needed, including the Aviation Component Leader, the aircraft Pilot, the Chief Scientist, and the Scientist(s)/Observer(s) who may be embarking in a manned aircraft, and ship personnel as required.
• Assignment of launch/recovery personnel and the handling system operator. Ensuring that all deck personnel are equipped with Personal Floatation Devices (PFDs), hard-hats, and proper footwear, and that common signals are understood by all. Verifying clear two-way communications between the deck,

the launch and recovery system control location, and the bridge watch-keepers.
• Continuous evaluation of conditions and hazards during the flight operations.
• Establishing an unambiguous decision process for an abort of flight operations and aircraft recovery in the event of an emergency, inclement weather, or other unanticipated event.
• Establishment of an area of the deck that is off limits to non-essential personnel during launch and recovery of the aircraft.

The institution's Procedures Manual must address unique operations such as multiple simultaneous aircraft operations, or aircraft operations conducted simultaneously with other deck or over-the-side operations or with embarked submersible assets such as HOVs, AUVs, and ROVs, drills, and coordination with other research vessels present in the immediate area.

13.4.5 ISM AND SHIP-BASED AIRCRAFT OPERATIONS

All UNOLS Ocean Class and Global Class ships operate under ongoing safety management systems as per the International Safety Management (ISM) treaty and national implementing laws and regulations. Smaller vessels in the UNOLS fleet are encouraged to comply with ISM to the fullest extent possible. ISM Procedures for UNOLS vessels already mandate specific written plans for over-the-side science operations, however these may be fairly generic. Ships conducting launch and recovery of aircraft shall also define specific procedures and include them in their reviewed and approved ISM handbooks and other documentation, as required. These will likely include, at a minimum:

• Trained personnel on the ship required for launch and recovery operations.
• Chain-of-Command and designation of lead personnel during operations.
• Communications between the deck, the handling system control position, the bridge and the aircraft.
• Weather and operational safety constraints.

13.4.6 SHIP-MOUNTED AIRCRAFT LAUNCH/RECOVERY SYSTEMS

Additional information regarding handling systems for embarked manned submersibles is covered in the HOV Safety Standards, Chapter 6. In a general sense, these provide a useful template for the safe installation and utilization of aircraft handling systems.

In broad terms, an aircraft handling system for the launch and recovery of a UAS Is typically a robust, specially designed piece (or pieces) of precision equipment, built, operated and maintained to exacting standards so that the delicate aircraft platform can be safely and securely transferred from the deck, and launched into the air, and then recovered after the flight--while under full control during the widest possible window of sea-state conditions. The handling system:

• Must meet operational standards and be certified by the manufacturer and possibly under ABS, NAVSEA or other appropriate system certification, or another classification society.
• Ship and aircraft system operators must make themselves aware of any regulations, promulgated by the USCG or the FAA, or internationally by ICAO, or classification societies that may require equipment to be type-approved and periodically tested or re-certified in compliance with regulations related to the anticipated operation and deployment of an aircraft, manned or un-manned.
• Must have operator qualifications and training established by the aircraft operating institution.
• The use of an aircraft launch and recovery system for purposes other than its intended purpose of launching and recovering aircraft requires approval of the manufacturer and/or certifying authority.

13.5 REQUIRED BY RVSS UNDER CERTAIN CIRCUMSTANCES
None.

13.6 RECOMMENDATIONS AND BEST PRACTICES
(These will be contained in a separate document to be provided by the UNOLS Scientific Committee for Oceanographic Aircraft Operations.)

13.6.1 ADDITIONAL DESIRABLE CAPABILITIES OF AN AIR-CAPABLE SHIP

A vessel operating an aircraft should offer adequate space for routine servicing and maintenance of the embarked aircraft, its sensor systems and support equipment. This may include such elements as a machine shop, an electronics shop, or a dedicated space on board for these functions. Separate storage space for the aircraft's spare parts should be provided in a secure location where they will not be depleted to meet other routine ship maintenance needs. Since maintenance and battery charging or re-fueling often take place at night, adequate lighting of the aircraft work area should be provided. The lighting should be aimed so as to illuminate the aircraft and the working environment around it, while not blinding the bridge watch-keeping personnel.

The ship should be equipped with a tracking system, which can continuously and without interruption update the position of the aircraft while it is operating. Every effort should be employed to provide timely data of considerable utility to the science investigators and also enhance safety and security by providing enhanced situational awareness, both during normal operations and during an emergency.

Dynamic positioning systems may enhance the ability of the support ship to carryout the aircraft's mission. These systems serve to efficiently keep the vessel within a defined circle of position which capability may be useful during recovery operations. Some systems permit automatic tracking of an off-board vehicle's transponder, moving the surface ship in concert with the other platform.

13.6.2 TRAINING SHIP-BASSED AVIATION SUPPORT PERSONNEL

Aircraft support from a surface ship is sufficiently unique as to require specialized training for personnel involved in these operations. This training should include the Master, the bridge watch-keeping officers, the radar observer and communications and tracking operators, off-board recovery personnel (if an aircraft that lands in the water is used), deck personnel, and launch/recovery system operators. As required for seagoing personnel under ISM, a syllabus for training shall be established and sign-off documents of training milestones and qualifications shall be maintained.

Emergency exercises and drills shall be held to verify the readiness of the rescue and emergency equipment and the personnel tasked with its employment. Pre-flight briefs and post-flight debriefs along with post exercise critiques are useful practices for advising personnel about performance needs and opportunities for improvements.

Institutions operating oceanographic aircraft are encouraged to share experiences through professional organizations, technical journals and publications, aircraft operations sessions at national meetings and informal communications.