Appendix A: Lessons Learned

The NOAA Unmanned Aerial System (UAS) Demonstration Project Using the General Atomics Altair UAS.
Interim Report, May 1, 2006.

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Number	Title	Description of Driving Event	Lessons Learned	Recommendations	Number	Recurrence Control	Comments Specific to Dryden Personnel
Altair 2005 001	Ops Engineer documentation for UAV flight activities.	Troubleshooting problems associated with UAV flight operations.	It is difficult to recreate flight events without precise log book entries. Problem troubleshooting often requires specific information such as time, altitude, temperatures, etc.	The assigned Ops Engineer should develop and maintain a UAV flight activity log book to record real-time mission observations (i.e., what went right, what went wrong, etc.). Log book entries should be recorded in the exact time each event occurred or was observed.	Altair 2005 001	The log book proved to be invaluable during post-flight troubleshooting and for briefing the team (as well as senior management).	1. The Red Book has to have the Project and DFRC Mishap Plans in it (the Project Mishap Plan should ALWAYS reference the DFRC Mishap Plan). 2. The Mishap Red book needs to be updated with better checklists and what-to-do kind of information - make sure the Red Book procedure is clear and straight forward by performing a practice read-thru with the appropriate team members. 3. Have phone numbers of all ARTCC's, ranges, sheriff's dept's, etc. on hand and tailored to the mission. 4. Need to make some improvements to the Y005 Airborne Science Flight Authorization form. For example, change the name & put in more boxes that can be checked. Reorder the predicted T/O and actual T/O time boxes, etc. 5. Special Mission Rules were developed for NASA Pilot training during these Altair missions. See 050505 Status Update package, page 13 (available from Greg Buoni, NASA Dryden, 661-276-7548)
Cont #1					Cont #1		(Continue LL#1)6. There is a desire by DFRC management to get pictures/video of the Altair in flight. An attempt was made on one occasion to use the Chase aircraft and personnel to do this - the results were not satisfactory. An option would be to hire the "Lear Jet people" to obtain these pictures/video. 7. Contrary to expectations, the project found it took SIGNIFICANT NASA DFRC personnel resources to support these Altair flights. 8. NASA DFRC Frequency Manager cannot "blanket" the GA FCC (not FAA) license to broadcast the airborne C-band Line-of-Sight (LOS) telemetry transmitters because DFRC doesn't have a C-band telemetry FCC license. 9. Which Sport/Joshua phone number is recorded?
Altair 2005 002	Coordinating UAV flight operations with owners of special use airspace.	UAV flight operations into/through airspace controlled by various military organizations (i.e., Vandenberg AFB, Pt. Mugu, Edwards AFB, etc.).	Each airspace owner has a different process for coordination/approval for UAV flight operations within their respective areas. The coordination/approval process can be very time consuming.	Pre-coordinate with all applicable military organizations well in advance of each planned flight into/through their respective airspace.	Altair 2005 002	No problems/delays were encountered after the unique coordination requirements were identified, documented, and performed.	1. Both the Pt Mugu and VAFB ranges WANT (not necessarily require, but it is VERY smart to do this!) to be briefed on and paid to support proposed operations in their airspace or warning areas so that they can be aware of, advise, and approve of the operations. To fly in Pt Mugu or VAFB airspace, they have to brief the project to their management to get their local management approval it is OK to do whatever. The project doesn't HAVE to send money to do stuff in their area, but just to get their RCO on station costs ~$1K per 3 hours of RCO support during the week. It is well worth that money. Their RCO can help pick a safe place to "scuttle" the aircraft and avoid ships, buildings, etc. 2. To get approval to fly in Point Mugu airspace, they want a "Test Plan" (we sent an "Operations Plan" since we weren't really planning to do "testing"). Several organizations wanted this Plan, including EAFB people.
Cont #2					Cont #2		(Cont #2) 3. Point Mugu wants to review the "Test Plan" and have an "Engineering Review Board (ERB)" meeting on it 2 weeks prior to doing any flying in their airspace. They can be very flexible with the timeframe (I think we gave them something like 1-2 days), but it pushes their system. VAFB also has a similar requirement. 4. If planning to use VAFB airspace, then the project needs to coordinate with VAFB RSO Jeff Claxton (he used to work in DFRC RSSO) (phone number and e-mail available from Greg Buoni) and Walt Schobel (phone number and e-mail available from Greg Buoni). They need to have the same test/operations plan that other ranges require. Some type of VAFB Safety/Engineering analysis must be performed by them to be approved to use their airspace. Altair needed to coordinate with VAFB because we had termed a planned spiral in the Pt Mugu airspace as the "Vandenberg spiral", but no VAFB approval was required since it was in Pt Mugu airspace. Note: VAFB airspace extends only 3 miles off the coast.
Cont #2					Cont #2		(Cont #2) 5. Pt. Mugu RCO needs phone # of pilots in the GCS for backup coordination. 6. Warning Area contact numbers: - Owner of the warning areas (off the West Coast) W-283, W-285A, W-513, W-260 is FACSFAC. A point of contact is Jeffery Benander at 619-545-1757/1777. - A Point Mugu RCO is Jeff Dibler 805-989-8280. 7. Need to keep Pt Mugu and Plead Phone numbers for future use. 8. Bill McMullen/DFRC RCO is a GREAT interface to the EAFB range and scheduling. 9. If crossing R2508 airspace outside of R2515, make sure to coordinate with Howard Travis/Gary Dunden (sp?) (277-2508), the R2508 airspace owner. 10. Point Mugu airspace (W532 - off VAFB, and W 289 around the Channel Islands) is divided into small sub-sections of their total airspace. Pt. Mugu/Kurt Dulka (805-989-9815) supplied those maps to us. The sub-sections are what the Pt. Mugu RCO's will schedule for the project.
Cont #2					Cont #2		(Cont #2) 11. Warning Area W-93 has "ATCAA's" (Air Traffic Control Assigned Airspace) areas they control and don't want aircraft flying in over the Pacific Ocean, but they aren't on any Sectional or IFR chart. You have to talk to the Western Air Defence (WAD) schedulers to find out that they are there. The Altair project obtained a list of some of them.
Altair 2005 003	Coordinating UAV flight operations with the Federal Aviation Administration (FAA).	UAV flight operations outside special use airspace involving one or more FAA facilities.	The FAA would prefer that UAV flight operations be identical to piloted A/C, with respect to flight in the National Airspace System (NAS). Since UAV's normally require a Certificate of Waiver or Authorization (COA) issued by the FAA, detailed coordination must be performed well in advance of the flight activity (often several months)	Work with the FAA Regional Office in your area for help in applying for a COA (if required). Start the COA application process 3-4 months prior to first flight and submit the COA paperwork at least two months in advance of your planned first flight. Set the COA end date to a time beyond the projected length of the flight activity to mitigate likely schedule delays.	Altair 2005 003		1. FAA MOS (Military Operations Specialists) for ZLA (Los Angeles, Ca zone), ZOA (Oakland, Ca zone), ZSE (Seattle, Washington zone) phone numbers, email addressed documented here: ZLA-MOS 661-265-8287 e-mail: 9-AWP-ZLA-MOS@faa.gov, ZOA MOS 510-745-3334 e-mail: 9-AWP-ZOA-MOS@faa.gov, ZSE MOS 253-351-3523 e-mail: 7-ANM-ZSEAT-MOS@faa.gov 2. After the 72 hour flight plan notice is put into the FAA - if the flight is cancelled or aborted, need to call and/or e-mail affected FAA offices (MOS at ZLA, ZOA, ZSE). 3. Submitting a wide variety of mission plans (i.e., 5) to the FAA at a time (3 days in advance), and then wanting to pick the one to actually fly 24 hours in advance doesn't work for the FAA. However, having a prime and a back-up mission seemed to be OK with them, as long as they weren't "too involved" from an FAA Air Traffic Control (ATC) perspective. 4. There is some maximum number of waypoints that can be submitted in a mission to the FAA. The FAA computer system can only hold a certain number of waypoints. What is this number???
Cont #3					Cont #3		(Cont #3) 5. The DFRC Mission Manager worked well with the FAA to negotiate the Certification of Waiver or Authorization (COA). This Altair COA was apparently the first of its kind - a "standard" procedure and timing for request submission needs to be developed. 6. For post-flight tracking, it is useful to get the names or operating initials of the people we talk to at the FAA centers on the phone. Especially as related to when we notified the different FAA Centers when a mission was aborted or cancelled. Probably also on who we gave the 72 hour notification to. The official interphone/radio identifier for FAA personnel is their unique operating initials. 7. The Project did obtain an FAA Deviation to fly the Altair in Reduced Vertical Separation Minimum (RVSM) airspace (29k ft to 41k ft). 8. The active NASA-DFRC FAA Certification 0f Waiver or Authorization (COA) for these flights required a chase aircraft whenever Altair was below 18k ft and outside of special use airspace (restricted areas, warning areas, MOAs, etc)
Cont #3					Cont #3		(Cont #3) 9. It seems like it may be more difficult in the future to obtain an FAA Certification of Waiver or Authorization (COA) for UAV aircraft.

Altair 2005 004	UAV flight planning.	UAV flight operations carrying NASA-sponsored and contractor experiments and sensors.	When working with multiple organizations (NASA, Contractor, Principle Investigators), the division of responsibilities must be clearly defined.	Evidence of Recurrence Control Effectiveness: (if applicable)	Altair 2005 004	Once established, the UAV flight operations went smoother.	1. The Mission Manager shouldn't be doing flight planning. The Mission Manager should work the COA process and the Ops Engineers (working with GA and the scientists) should work the flight planning. 2. When making a plan to fly missions several days in a row, and are forced to cancel the first day, only cancel out of the first and try your best to fly the second/third missions as planned. It will work better with the FAA and the ranges. 3. Don't try to schedule the EAFB range if you don't know the required frequencies, let GA do it. 4. Flight Planning - There was not good coordination between the 4 (or so) interested parties. GA Pilots/NASA Mission Mgr/NASA Ops Engr (Flt planners)/DFRC RCO/Pt Mugu people. Worked well with GA doing 24 hr and 2 hour flight plan and EAFB range, submission, NASA doing 72 hour FAA notification (rather have Ops Engr do it, not Mission Manager), NASA do Pt Mugu (and other) range and use DFRC RCO to smooth EAFB range scheduling. Need to clarify roles and responsibilities and set up a team with regular meetings and communications that is responsible for getting these
Cont #4					Cont #4		(Cont #4) 5. Between the General Atomics/NOAA/NASA DFRC teams, there did not seem to be a clear definition of responsibilities, especially with respect to flight/mission planning. 6. Need to have the mission plan in graphic format (on aircraft type charts, like Sectionals or printed out from flight planning software), not just in Lat/Long points. Everybody understands this better/quicker. 7. General Atomics deals with waypoints in "Degree-Minute-Second" formats, not decimal degrees (the way the NOAA scientists like to work with waypoints). This is the way their Jeppeson flight planning software likes it. The Ops Engineer should work with the Mission Manager to coordinate this (a users interface document would be a good idea)
Altair 2005 005	Continuous Risk Management (CRM) of flight projects using contractor-provided UAV's.	Initial flight operations with a UAV in the National Airspace System (NAS).	When working with UAV contractors, NASA often finds that the contractor's policies and procedures are very informal. NASA's CRM policy needs to be (appropriately) enforced into the project's flight activity.	Flying UAV's in FAA airspace became more routine when these processes were implemented.	Altair 2005 005	This was accomplished and worked well on a UAV project in 2005.	1. The "Focused Fault Tree" that DFRC Brent Cobleigh and Steve Jenson prepared for the AFSRB was very good. It probably has to be updated and input into the "Sapphire" Fault Tree program (Code SF), and maybe even a FMEA analysis done on it. 2. The Independent Review of General Atomics procedures and policies that was performed by Matt Graham was VERY USEFUL and comprehensive. Many questions and problems were avoided at the AFSRB because of that team's comprehensive and thorough audit of GA's operation. 3. General Atomics Preflight/Crew Brief was not like a DFRC "Crew Brief" in that it did not include all the Mission Rules and Go/No-Go's. 4. General Atomics Post-Flight briefing was not like a DFRC Post-Flight brief. It was much more informal and covered topics VERY quickly. 5. General Atomics doesn't know the DFRC briefing formats (AFSRB, Tech Brief, etc), or how they flow. A DFRC project person needs to predigest their charts and information and reorganize the provided material to make it appropriate for the briefing. The Altair Project did this with later briefings, and GA was OK with this practice
Cont #5					Cont #5		(Cont #5) 6. Do a "dry run" of the charts, with all briefing participants, prior to AFSRB, Tech Briefs, and maybe Status Updates. It helps the team to come together and tell a cohesive story. 7. NASA DFRC has not seen/does not understand what General Atomics uses for what DFRC calls "Mission Rules" and "Go/No-Go" criteria. Fortunately, through discussions with GA personnel and observing their behavior before, during, and after flights, it is clear that GA does implement these concepts (although they may not have them written down as DFRC is used to). 8. NASA DFRC does not understand the "certification" envelope of the Altair aircraft at an aircraft or subsystems level (e.g., what altitudes can it fly at and for how long?)
Cont #5					Cont #5		(Cont #5) 9. Documenting the "Memo for the Record" responsibilities and Decision Flow Diagram between General Atomics and NASA DFRC was good. The RSO/Senior Ops Rep "Decision Flow Diagram" was good documentation of the logic tree for scuttling the aircraft. It was very important that this was jointly agreed to with NASA DFRC and General Atomics. 10. The discussions with the GA Chief Pilot and GA Project Pilot with the DFRC test pilots was a good exercise in getting to know who was operating the aircraft and how their thought processes went.
Altair 2005 006	Conducting UAV flight operations at contractor's facility.	Observing UAV flight operations at a contractor's facility.	Many contractor flight operations processes are widely different from NASA processes and, in some cases, very informal. It is imperative that the NASA project team be made aware of these differences and is able to make adjustments/corrections, as appropriate.	The NASA project team should observe the contractor's flight operations well in advance of conducting NASA-sponsored activities.	Altair 2005 006		1. General Atomics generally (almost always) flies at 8,500 ft MSL between Gray Butte and EAFB R2515. 2. The General Atomics FCC license to transmit on the aircraft (mobile) C-band downlink transmitters was for within 160 KM of ADELANTO, Ca. Altair C-band transmissions were not authorized by the FCC outside of this distance. General Atomics did put in a request with the FCC to extend the range to 200 NMI from Adelanto, Ca - no word yet on the FCC response. Still not approved as of 5/27/05. 3. General Atomics flies and does flight planning like general aviation pilots (not like the military/test pilots that DFRC is used to working with). 4. Any pilot training planned during a flight must be briefed at the Preflight Crew Briefing, along with appropriate Mission Rules and Go/No-Go's. 5. Be aware that a large group of people may gather around the pilots (in the GCS) when problems occur (e.g., "Code Yellow" on 5/17). Could cause Flight Crew communications problems.
Cont #6					Cont #6		(Cont #6) 7. Travel times, following the speed limits: DFRC to Gray Butte, about 55 minutes. Tehachapi to Gray Butte - 1.5 hours (Hwy 14 to Ave. D, to Ave. E, to 140th East, to Ave. J, to 240th East to Ave. R-8). 8. It is good for the Operations Engineers to be able to access the EAFB weather forecasts from a PC or laptop while at Gray Butte. 9. DFRC Ops Engineers need e-mail while at Gray Butte supporting flight operations. ODIN will give "loaner laptops", if necessary. A remote access "FOB" is required for access to DFRC e-mail accounts. 10. DFRC Ops Engineers need access to the internet while at Gray Butte to perform the "Falling Leaf" analysis. This does not require access to the DFRC network. 11. DFRC Ops Engineers need a cell phone while at Gray Butte supporting flight operations. ODIN will give "loaner cell phones", if necessary. Cell phone reception is bad in the "Command Center" at Gray Butte, but is pretty good on the rest of the Gray Butte installation.
Cont #6					Cont #6		(Cont #6) 12. A way to contact DFRC Ops Engineers, Senior Ops Reps, and/or RSO's while in the Command Center should be found (cell phone reception is poor). 13. The General Atomics Project Engineer is a critical member of the team and is a primary source of information about what is going on in GA for the project (this is especially true when there are significant aircraft-related problems, as was experienced during this demonstration). 14. Maps to General Atomics facilities at Gray Butte and El Mirage are very helpful. 15. General Atomics keeps the Ground Control Stations (GCS) very COLD - dress accordingly. This applies to the Command Center and to any GCS trailer.
Cont #6					Cont #6		(Cont #6) 16. Food & beverages at General Atomics Gray Butte Facility: A "roach coach" arrives for breakfast around 6:30 am and for lunch at sometime between 11 am and 11:30 am. The closest other food (other than snacks) is in Lake Los Angeles or the town of Phelan, about a 20 minute drive each-way. At least one coke machine is in the Command Center. The Air Force detachment has a small "honor-type" snack bar in the front of their building with snacks, some food, candy, sodas, and Gatorade - prices are very reasonable. 17. NASA DFRC personnel access to the General Atomics facility at Gray Butte, El Mirage, etc. went well. Using Shalane Reeves/Infinity to communicate the access information to GA seemed to go well. You need to provide your name, company/Gov't organization, contractor or not, citizenship, clearance level, and duration of visit. Shalane knows how to transmit that information to General Atomics
Cont #6					Cont #6		(Cont #6) 18. Altair Ku Satcom time for specific flights in the future should be "bought" from satellite companies "MONTHS" in advance, in the view of the satellite providers. Because of the "flight test" environment that the project found itself in, much of this Satellite time was not used, and other money had to be found to schedule new time. There is a problem with scheduling satellites months in advance for aircraft flights schedules that are relatively fluid. 19. The 14" skyball borrowed from the USAF did "freeze-up" and cease to operate after several hours above 40,000 ft MSL

Cont #6					Cont #6		(Cont #6) 20. During the last flight, a headset was requested for the Senior Ops Rep to listen to communications with the FAA/Sport. The request was denied because there were several other GA Predator operations that day. The reply was "this is all the headsets we have". In reality, one of the people already on the headset was not a required member of the flight team. The Ops Engineer should have followed up on the request with the GA Project Manager until the request was granted. 21. An "emergency" landing capability using Ku Satcom (instead of C-band Line-of-Sight) is extremely undesirable to General Atomics. There is an option to preposition a Ground Control Station (GCS) at a remote site to be used as an emergency divert fields. General Atomics has landed 1 airplane using the Ku Satcom link. For this Project, the EAFB lakebed was cleared to attempt this type of landing. Pt. Mugu, San Nicolas Island, and VAFB were not cleared to attempt this type of landing.
Cont #6					Cont #6		(Cont #6) 22. DFRC Management may not be comfortable with how General Atomics performs chase operations (i.e., not a "tight" formation and not above ~12,000 feet). 23. The "Daisy" waypoint is at N34° 15' 13.77", W120° 08' 31.47". 24. For the Project missions over the ocean, it was OK with General Atomics and NASA DFRC to talk to the Oakland Oceanic controllers on the phone (vs VHF/UHF radio). 25. On the 4/14/05 flight, we watched the Pilot-in-Command (PIC) Ground Control Station (GCS) rack "lock-up". We then watched the pilot switch over to the "co-pilot/sensor operator" station, reboot the original rack, and transfer control back to that original rack. 26. General Atomics doesn't have a problem doing night take-offs and landings with Altair. That is why the 2nd fwd looking camera is an IR type camera.
Altair 2005 007	UAV System Safety Working Group (SSWG) participation requirement.	UAV flight operations with contractor as UAV operator.	The project's SSWG must be comprised of representatives from each participating organization (e.g., NASA, contractor, experimenter, etc.) and must meet on a regular schedule.	Form the SSWG as early in the project's conceptual phase as possible. Hold a minimum of one SSWG between each flight. Perform a joint hazard analysis for flight, ground, and range safety and report the results in a NASA STD format. Produce a System Safety Plan (SSP) and define each participant's responsibilities for the entire risk management process.	Altair 2005 007	Getting through the NASA flight approval process was much easier after these recommendations were implemented.	
Altair 2005 008	UAV Range Safety/Public Safety for flights in the National Airspace System (NAS).	First time performing UAV operations outside special use airspace.	1. Calculating the Expected Casualty (Ec) number for UAV flight over public land was an evolving because the aircraft/fleet has limited flight time outside special use airspace, as well as an extremely long range capability. Ec must take into account the aircraft's reliability, the changing sphere of influence (exposure to the public) as fuel is consumed, and other environmental conditions. 2. At the request of the Office of Safety & Mission Assurance, the project team developed a "Falling Leaf" analysis tool to predict the UAV impact location at any point on the planned route of flight (mitigation for public safety risk).	Engage the RSSO early in the project. The RSSO must calculate the Ec numbers for the entire mission flight path (inside and outside special use airspace). Note: The Range Safety Officer (RSO) is required to perform hazard mitigation inside special use airspace and the assigned Senior Operations Rep (SOR) performs the same responsibility outside special use airspace (i.e., the NAS).	Altair 2005 008	Successfully demonstrated in 2005 UAV missions.	1. Need to get the DFRC Range Safety Office involved early in the project so they can start running Ec numbers early (ours were being reworked after AFSRB charts had been submitted). 2. DPD 8740.1A Range Safety Policy for Dryden Flight Research Center (DFRC) dated 7/13/2000 specifies "Real time hazard mitigation actions shall be performed by a RSSO or AFFTC certified Range Safety Officer (RSO)." This project used that to require an RSO while in R2515, but delegating the RSO responsibilities to the Senior Ops Rep (SOR) outside of R2515. 3. The RSSO ended up being able to use Predator A flight history hours and failure history to help reduce the Ec predictions for Altair. 4. RSSO Ec predictions for long endurance UAV aircraft may need to be refined and updated. 5. The DFRC RSO provided voice communications (with their Nextel radio setup) with Sport only when the Altair Ku system was down (airborne voice relay wasn't working). The Altair pilot usually contacted Sport directly. 6. Need to renegotiate with FAA on best/safety route to the Pacific coast.
Cont #8					Cont #8		(Cont #8) 7. "Falling Leaf" analysis: Lawrence Davis asked us to provide a predictor of where Altair would strike the ground if it went into an uncontrolled descent (flat spin) with a 5000 ft/min descent rate, taking into account day-of-flight predicted winds at altitude. Ops Engineers Trent Theriault and Dave McAllister produced the "Failing Leaf 2" application with instructions on how to get the data off the internet. The analysis assumes NO aircraft inertia as it falls through the different wind profiles. The intent is to analyze the flight ground track with respect to the predicted distance it would fall off the track and to adjust the ground track as much as possible on the day of flight (real-time with the FAA controllers) so that densely populated areas (yellow areas) on an aircraft Sectional Chart will not be impacted. By the way, General Atomics will not deliberately fly one of their aircraft directly over one of those yellow areas.
Altair 2005 009	UAV project team formulation and best practices.	UAV flight operations from a remote (off-site) location.	It was difficult to keep the entire project team informed of the up-to-the-minute status (NASA, contractors, and experimenters) and to keep the flight support activity properly staffed with the right personnel.	Create a central "Event Line" that team members can call for updates. The Ops Engineer should develop a "Phone Notification Tree" of all flight-support personnel. To the extent possible, avoid critical staffing changes late in the project. Provide staffing of critical positions as early as possible to allow people to become intimately familiar with the operation before actual flight ops begins. For UAV flight greater than ~6 hours, more that one Ops Engineer and Senior Ops Rep are needed to fully support the mission.	Altair 2005 009	Proven effective on recent UAV operations.	1. Keep Patti Kinn notified of mission status (DFRC Flight Ops)...or else! 2. Keep Code O Director and Deputy informed of Project status in person, if at all possible. Give them a heads-up for AFSRB, Tech Briefs of the issues and solutions, etc. 3. The phone notification tree worked well (see Greg Buoni). Have plenty of room on the form for call-backs (canceling, mission progress, etc.). 4. Flying UAVs demands LOTS of DFRC pilot office support to act as Senior Ops Reps (5 pilots for 20 hour mission, 2 pilots for 8 hour mission). 5. Need 2 Ops Engineers to support flight ops full time, especially from the point of ~AFSRB/Tech Briefs and subsequent. Need 3 to support missions longer than 12 hours 6. EAFB BioEnvironmental Safety Office working with Bette Davis, DFRC Radiation Safety Officer. The "radiation letter" from Bette Davis was very helpful in describing the radiation source and the lack of a hazard that it presented.
Cont #9					Cont #9		7. The DFRC team of people that ended up working these missions to the end gained a lot of knowledge in working with General Atomics and watching their operations that cannot be easily replaced. The basic team should continue to be assigned to Altair/Predator B tasks until more of the DFRC organization can see and learn about these operations. 8. A Chief Engineer was assigned to the Project (prior to AFSRB). Soon after the AFSRB, the Chief Engineer became busy on other tasks and vacations. The Project was essentially without a Chief Engineer from Tech Briefs through flights. This was detrimental to the team and caused organizational confusion in preparation for the missions.
Cont #9					Cont #9		9. A Project Manager had been assigned to the Project for a long time. The Project was essentially his "baby". During the time just prior to beginning flight operations, he left the agency and there was no one to step into his place smoothly. The duties of the Project Manager fell to two people as additional tasks for their already full plates. There was not a clear division between what these two people were responsible for, and the division seemed to change week to week. 10. Several people on the DFRC Altair Project team (Chief Engineer, Ops Engineer, System Safety Rep, Range Safety Rep, and Pilot Office Rep) were assigned to the project only about a month before the AFSRB, and some even after that. This is not sufficient time to become knowledgeable about a new aircraft/system, identify potential issues, resolve those issues, and make a coherent AFSRB presentation. The lack of preparedness showed at the AFSRB meeting. For projects that are said to represent "The Future of DFRC", the DFRC Project team should be assigned earlier.

Cont #9					Cont #9		11. Because the Altair/Predator B aircraft and Global Hawk aircraft are built by different manufacturers, have different basic operational philosophies (manual control vs. preprogrammed), they both will require a relatively large number of dedicated DFRC employees to support. The two DFRC project teams should not have many common members. 12. The NASA DFRC Project team needs to tie in with Public Affairs better to increase the potential for news releases on a day to day basis during the missions.
Altair 2005 010	Senior Ops Rep (SOR) responsibilities during UAV flights outside Range Safety Officer (RSO) jurisdiction.	UAV flight operations in the National Airspace System (NAS).	Establish clear lines of responsibilities between the RSO and SOR prior to flight outside special use airspace.	- Allow non pilots to act as SOR. - Allow the SOR to phone into the preflight briefing to reduce the total time on-site during long missions. - The SOR should closely monitor the pilot operating the UAV (especially how the pilot manages/updates the "lost link/emergency mission"). - The SOR must perform the RSO's duties when outside special use airspace.	Altair 2005 010	Proven effective on recent UAV operations.	
Altair 2005 011	Performing UAV science missions with other government agencies.	UAV flight operations involving NOAA in June 2005	1. To the extent possible, assure an early exchange of information for customer-provided scientific instruments/payloads (i.e., at least 1 year in advance). 2. In support of Item #1., identify points-of-contract (POCs) for all participates as early in the project as possible. 3. Send the "Experimenters Questionnaire" as early as possible to help mitigate potential problems with experiment/payload integration. 4. Submit a mission plan early. Detailed flight plans should be submitted 6 months early and should be submitted with the SOW. 5. When using rented satellite time to perform over-the-horizon communications with a UAV, get the satellite contract in place as early as possible to mitigate delays/schedule conflicts with other users. 6. Despite the problems encountered with the flights, the NOAA representatives were VERY HAPPY that NASA DFRC was involved in the process. The NOAA representatives told their management that they would not do any UAV work without NASA DFRC being involved.	Continue working with NOAA (or agencies like them) in the future.	Altair 2005 011	Will be determined by success of future missions.	
Cont # 11			(Cont #11) 7. NOAA had a video repeater screen set-up in the conference room at the General Atomics Gray Butte Command Center facility. This worked well for NOAA to put Digital Camera System (DCS) out onto the internet for their other NOAA sites to see real-time pictures. 8. Patti Kinn/Operations worked weather balloon scheduling directly with the NOAA scientist and with EDW, VAFB, Pt Mugu, and San Nicolas Island. That seemed to work VERY WELL! 9. During the April and May flights, the NOAA instruments had no significant problems. The problems encountered were with the Altair aircraft and Ground Control Station (GCS) systems (thermal and vibe (?)). 10. Once a flight is planned, the DFRC and Pt. Mugu RCO's like to see a single flight plan summary that just has the reserved range times on it.		Cont # 11		
Cont #11			(Cont #11) 11. Need to get all of "Eric's" (from NOAA Boulder, CO) mission flight plans for each of the missions (Channel Islands, Trinidad Head, Atmospheric River, Cross Troposphere, etc), so we can submit them in the future if we need to (or at least to collect in one place all the ones we do have)		Cont #11		

Altair 2005 012	System Safety early involvement in UAV Risk Management process.	Late inclusion of Safety & Mission Assurance into the project activities often elevates the level of risk.	Project/Program Management should not wait until the later stages of a program/project before involving System Safety personnel. This delay greatly elevates the level of residual risk. The most effective and cost efficient stage to infuse safety into your system is in the concept and design phases.	Include System Safety in the project team at the earliest stage (typically in the Conceptual Phase) and continue the risk management effort until project completion.	Altair 2005 012	The primary risk mitigation techniques are (in order of precedence): 1. Design for minimum risk, 2. Incorporate safety features/safety devices, 3. Incorporate warning/caution/detection devises, and 4. Develop special procedures, training, and personnel protection equipment. If System Safety is not actively involved in the Conceptual/Development Phases of a project, it is nearly impossible to "Design for minimum risk" or to "Incorporate safety features".	
Altair 2005 013	UAV experimenter payload risk reduction.	Experimenters desire flight time on ROAs to perform various research mission.	An early exchange of information with the Principle Investigator (PI) regarding an experiment's interface with the aircraft platform is imperative for reducing risk.	Require the experimenter to provide an Interface Control Document (ICD) as early as possible in the project/program timeline.	Altair 2005 013		
Altair 2005 014	Effective UAV project teaming results in risk reduction.	The project team was not co-located (e.g., NASA project personnel at DFRC, aircraft provider at El Mirage/Gray Butte/Rancho Bernardo, and PIs at various NASA & NOAA facilities). Typically, daily face-to-face communication is required to reduce programmatic risk	The lack of (or limited) face-to-face contact with other participating team members increases risk to mission success. The ability to exchange information in a timely manner solves many problems relating to mission success, as well as to the safety of the people and property exposed to the flight activity.	To the greatest extent possible, co-locate project personnel at the same site/facility.	Altair 2005 014		
Altair 2005 015	High quality UAV Mission Planning reduces risk.	Undefined/unclear mission planning may result in higher risk to mission success.	Mission Planning activities were performed late in the project timeline and, therefore, resulted in schedule delays due to the unanticipated complexity of coordination/authorization required with the various airspace owners.	Establish a clear mission plan as early as possible in the project activity.	Altair 2005 015		
Altair 2005 016	Identification and mitigation of Flight Critical Single String Systems in UAVs.	Flight/safety critical single string systems increase safety risks to the aircraft and the public.	Early identification for safety critical single string systems is required to effectively mitigate the associated risk.	During the Preliminary Hazard Analysis effort, identify the aircraft's safety critical single string systems so that design features can be incorporated to mitigate the associated risk.	Altair 2005 016		
Altair 2005 017	UAV Project Documentation Approval Process.	The progress of the project team can be negatively impacted if an efficient documentation approval process is not in place with senior management.	The review/approval process for project documentation must be efficient to support the project schedule.	Pre-coordinate with senior management for a timely turnaround of submitted documents, procedures, plans, etc.	Altair 2005 017		
Altair 2005 018	UAV Global Positioning System (GPS) use and risk reduction.	When flying an ROA in military airspace, it is imperative that the project check the local NOTEMS to determine if any GPS jamming activities are planned.	On occasion, military ranges may perform GPS jamming excersizes that temporarily block the satelite GPS signal from being received by the ROA during flight operations.	Research any planned GPS jamming activities.	Altair 2005 018		
Altair 2005 019	UAV Support Services contract for satellite communications.	For UAV operations, over-the-horizon communication is attained through the use of satellites. A contract is required to purchase time on the satellite and the satellite time is usually purchased for a specific period of weeks or months. Poor planning or schedule delays may result in a significant budget increase due to unused satellite time or the need to purchase additional time.	If the project gets behind schedule, they may waste a significant amount of money purchasing satellite time they do not use or the contract may run out before the project is ready for flight operations.	Do not purchase satellite time until you are sure that your schedule is on track to perform flight operations.	Altair 2005 019		
Altair 2005 020	Scheduling customer support for UAV projects.	Customers (experimenters) using UAV platforms normally require time to install and test their experiments/sensors. The project normally pays for the customer's travel expenses in order to install and test their experiments/sensors.	Slips in the project schedule will affect the experimenter's ability to gain access to the aircraft. This could seriously impact the project's budget if experimenters travel to the test site and the aircraft is not ready.	Manage the project so that wasted travel time is eliminated.	Altair 2005 020		

Altair 2005 021	UAV hazard analysis team.	Safety risk assessment process and presentation to the Airworthiness and Flight Safety Review Board (AFSRB).	When working a project with numerous partners/participants (e.g., experimenters, contractors, etc.), it is imperative that the team produces a single (joint) hazard analysis product.	Assure that the hazard analysis effort is well defined in the project's contractual documentation.	Altair 2005 021		
Altair 2005 022	UAV Tech Brief preparation/presentation.	Altair Remotely Operated Aircraft (ROA) science missions.	Use a proven/compliant process when preparing for a Tech Brief.	Maintain strict compliance with the applicable center procedure when preparing for a Tech Brief, including the following: - Use an approved checklist of mandatory presentation subjects - Perform a "dry run" with the presenters - Bring an attendance sheet - Bring the appropriate Flight Request form - Be prepared to record action items	Altair 2005 022	Previous successful completion of past Tech Briefs	
Altair 2005 023	Adequate platform testing for long duration UAV missions.	For the 2005 NOAA missions flown aboard the Altair UAV, the aircraft and its systems were tested on a 4 hour flight in the local restricted area. This did not replicate the planned 20 hour mission(s) over the Pacific.	A relatively short test flight does not adequately prove the reliability/performance of the aircraft and its systems for a planned long-duration research flight program.	To the extent possible, test the aircraft for the duration of the planned flight activity.	Altair 2005 023	Subsequent missions were adequately tested in longer duration test flights prior to exiting the restricted area. Mission success was attained with a much higher confidence level.	
Altair 2005 024	General UAV flight operations.	The project team did not have the capability to record voice communications between the UAV pilots and the ATC controllers during the Altair 2005 flight research missions.	After the initial series of flights, the project team felt strongly that they needed recorded voice date (radio and interphone) between the pilots and controllers.	If possible, provide the means to record all radio and interphone traffic between the UAV pilots and the ATC controllers.	Altair 2005 024	This capability/data is invaluable in case of an incident, close call, or mishap.	
Altair-NOAA 2006 025	Same as Altair 2005 003.				Altair-NOAA 2006 025		
Altair-NOAA 2006 026	Same as Altair 2005 003.				Altair-NOAA 2006 026		
Altair-NOAA 2006 027	Same as Altair 2005 013.			Receive information on scientific instruments/payload at least one year in advance.	Altair-NOAA 2006 027		
Altair-NOAA 2006 028R1	Identification of Points of Contact (POC).	Need to identify POCs early in campaign.	To meet milestones, you need to establish communication with the POCs.	Establish main lines of communications with all participating/responsible parties prior to formal flight research activities	Altair-NOAA 2006 028R1	Proved to work well for the 2005 NOAA missions.	
Altair-NOAA 2006 029	Same as Altair 2005 023.				Altair-NOAA 2006 029		
Altair-NOAA 2006 030R1	Same as Altair-NOAA 2206 028			Establish main lines of communications with all participating/responsible parties prior to formal flight research activities	Altair-NOAA 2006 030R1	Proved to work well for the 2005 NOAA missions.	
Altair-NOAA 2006 031R1	Internal approval process.	2005 Altair/NOAA flight research missions were delayed awaiting approval to fly.	NASA needs to speed up their internal approval process.	Revise the flight approval process for projects requiring a faster turn-around.	Altair-NOAA 2006 031R1		
Altair-NOAA 2006 032R1	Better scheduling for testing flight-critical hardware.	Delays caused because parts needed to be driven to Rancho Bernardo for testing.	Good scheduling prevents delays.	Elevate the priority of flight-critical hardware testing. Identify these items early in the project and plan for priority handling.	Altair-NOAA 2006 032R1	Later flights were more timely in the Altair/NOAA missions.	
Altair-NOAA 2006 033R1	Pilots are needed on site.	UAV pilot(s) did not always arrive for a scheduled flight early enough to allow mission planners/experimenters to coordinate their requirements with them.	Pilots should be available on site.	Set an arrival time for each flight that is agreeable to the flight crew and the testers.	Altair-NOAA 2006 033R1	Later flights of the Altair/NOAA mission were smoother and more successful	
Altair-NOAA 2006 034R1	Submitting Mission Plan.	2005 Altair/NOAA mission delays.	Submit a mission plan early.	Detailed flight plans should be submitted 6 months early, and should be submitted with the Statement of Work (SOW).	Altair-NOAA 2006 034R1	Later flights were smoother and more successful.	
Altair-NOAA 2006 035R1	Satellite Contracts.	Delay in renting satellite time meant that the satellite we had provided less than adequate satellite coverage.	Satellite contracts should be in place early to get the most cost effective pricing and best satellite coverage available.	Detailed flight plans should be submitted 6 months early, and should be submitted with the Statement of Work (SOW).	Altair-NOAA 2006 035R1		
Altair-NOAA 2006 036R1	Communications.	Loss-of-mission setbacks due to communications problems between the ground station pilot and the aircraft.	Back-ups are required to prevent single point failures.	Provide a low band width back-up.	Altair-NOAA 2006 036R1	When possible, provide redundancy for flight critical/mission critical systems.	
Altair-NOAA 2006 037R1	Environmental conditions required for scientific instruments.	Laboratory space cannot be in a hangar where environmental conditions for instruments (e.g., blowing sand, insects) are poor.	Laboratory space for instruments should meet acceptable environmental conditions such as air quality, temperature and cleanliness.	Establish facility requirements for sensitive hardware and provide same.	Altair-NOAA 2006 037R1	Improvement was seen when this was provided for the Altiar/NOAA 2005 missions.	
Altair-NOAA 2006 038R1	Access to work space and tools after working hours.	2005 Altair/NOAA missions.	Team member need access to laboratory space and tools, outside of normal General Atomics (GA) work hours.	Coordinate early in the project's developmental phase with site managers to provide after-hours support when required.	Altair-NOAA 2006 038R1	This capability/data is invaluable in case of an incident, close call, or mishap.	

Altair-NOAA 2006 039R1	Aircraft maintenance records.	Altair/NOAA 2005 research missions.	Require (in the contractual documents) that the owner of the aircraft provide full maintenance records for the time period of the contract.	Coordinate early in the project's developmental phase with site managers to provide after-hours support when required.	Altair-NOAA 2006 039R1		
Altair-NOAA 2006 040R1	DFRCs expertise in Mission Planning	The suppport Chris Jennison and Greg Buoni gave in the coordination with FAA and in the flight planning area.	DFRCs expertise in Mission Planning.	Other NASA Center's/UAV flight research activities should seek the knowledge that Dryden engineers/mission managers have gained with regard to flying UAV's in the National Airspace System in 2005.	Altair-NOAA 2006 040R1		
Altair-NOAA 2006 041R1	Science has priority in flights.	Too many delays with the plane caused science priorities to be secondary. Future government agencies involved in atmospheric research are not going to be interested in funding engineering firsts.	Paying customers need to have priority in missions.	Set priorities early in the conceptual phase of a project with emphasis on the "customer's needs".	Altair-NOAA 2006 041R1		
Altair-NOAA 2006 042R1	Funding issues.	Funding continuity between government agencies and General Atomics needs to be improved. Specifically, during the start of the Altair project, NASA project management threatened to stop all operations while we were in field because the government agencies didn't provide enough funding to cover the following week.	Make sure funding is available and in place before and during missions.	Continually evaluate funding issues throughout the life of the project. Improve the process for managing programmatic risks.	Altair-NOAA 2006 042R1		
Altair-NOAA 2006 043R1	Flight conditions (cold temperature effects on experimental hardware and aircraft control systems).	Did not understand the full scope of temperature extremes in the plane. There was no data available on bay temperatures.	Experimenters need to know the flight conditions that their experiment will fly in.	The Experimenters Handbook needs to be routinely updated.	Altair-NOAA 2006 043R1		
Altair-NOAA 2006 044R1	Seven days a week aircraft availability for flights.	Operations of Altair must be able to occur on weekends when there is a science or operational priority.	Scientific occurrences are not confined to the 5 day work week.	Flight availability must match scientific occurrences.	Altair-NOAA 2006 044R1		
Altair-NOAA 2006 045R	A need exists for a NASA-owned Predator-B with NASA-run operations.	For the long term, using airplane manufactures that sell to the military as a contractor is not the way to go.	NASA needs control of the Predator-B and its operation.	NOAA and/or NASA should buy their own Predator-B and have their aircraft operations people run it, not a military contractor.	Altair-NOAA 2006 045R		
Altair-NOAA 2006 046R1	Update Experimenters Handbook.	The Altair Operators Guide to Experimentalists needs to be updated.	Outdated documents/manuals cause confusion and delay.	Keep manuals updated and current.	Altair-NOAA 2006 046R1		
Altair-NOAA 2006 047R1	MOU delays.	NOAA needs to get their funding together faster for the contractor, NASA, and individual NOAA teams. Part of the problem is the Department of Commerce MOU process. Every year the same business is conducted with NASA and yet a new MOU is needed.	Current MOU procedure creates delays.	NOAA needs to solve the MOU delay problem.	Altair-NOAA 2006 047R1		
Altair-NOAA 2006 048R1	Availability of spare parts.	Scientists need to solve their budget issues and have more spare parts available in the field to service and maintain their instruments.	Spare parts need to be on hand and available, especially in the field.	Plan early on to fund and procure spare hardware, especially when conducting flight research in the field.	Altair-NOAA 2006 048R1		
Altair-NOAA 2006 049R1	The FAA Certificate of Waiver or Authorization (COA) process limits the projects' ability to change flight plans in a timely manner.	The COA should not require a 2 day notification of changes.	We need to work with the FAA so that the COAs don't limit changes to the flight plan. We may need to follow an atmospheric event.	COAs need to be broad enough to handle contingencies in the flight plan.	Altair-NOAA 2006 049R1		
Altair-NOAA 2006 050R1	Forecasting atmospheric river, tropopause fold, stratospheric downwelling, and like events.	Forecasting of weather in both the troposphere and stratosphere is now a requirement for missions like the 2005 NASA/NOAA Altair project. The ability to forecast whether or not an event will occur (atmospheric river, tropopause fold, stratospheric downwelling) is a necessary thing for these missions. It was well done by David Fahey and his colleagues.	David Fahey and his colleagues (NOAA) were highly successful in forecasting troposphere and stratosphere events during the 2005 NASA/NOAA flight research project.	A science flight research project needs high level personnel available to reduce the risk of mission failure due to ever-changing weather patterns.	Altair-NOAA 2006 050R1		

Altair-NOAA 2006 051	Funding issues.	The project was underbid by General Atomics. The costs for instrument integration were considerable higher than originally estimated, and as a result scientists had an ongoing struggle trying to cover their basic needs. Some of the data analysis is still incomplete due to lack of funds (PMVS). In addition, project delays at Gray Butte resulted in increased costs for NOAA PIs and their crews, as well as for NASA and General Atomics.	Make sure the contractor has a clear understanding of project costs.	Make sure the contractor has a clear understanding of costs associated with instrument integration and other project costs before bidding the project.	Altair-NOAA 2006 051		