C-27J Capabilities and Cost Analysis Report

Submitted to

USDA Forest Service

Submitted by

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Table of Contents

List of Figures

List of Tables

Foreword

Figure 1 C-27J Aircraft

The USDA Forest Service (Forest Service) asked Convergent Performance LLC (Convergent) to accomplish an independent analysis of the C-27J aircraft to assist the Forest Service in determining if the C-27J aircraft could be used to accomplish the Forest Service's aviation missions. Specifically, Convergent was asked to provide an analysis of the capabilities of the C-27J in the context of each of the Forest Service missions, provide scenario based capabilities data (performance under fire season conditions at selected Forest Service fields), and a lifecycle cost analysis. Convergent was asked to do this analysis based on our relationship with current C-27J front-line users.

During the course of the analysis, the Forest Service requested a few minor changes in the specifics to the original tasks. One of those changes was to have the results of the analysis accelerated in order for Forest Service officials to have the information in hand to engage in timely debate. Convergent provided a preliminary report to meet this requirement and has done everything possible to accelerate the delivery of the final analysis report to meet the Forest Service's dynamic needs without compromising quality. An additional request was to refocus the scenario based capabilities analysis from austere fields to fields the Forest Service might employ in a "last mile forward" delivery strategy. In order to provide a more complete picture, Convergent has provided analysis and data for a representation of both austere and "last mile forward" locations.

This analysis was requested as a result of the US DoD's announcement to discontinue the military C-27J program and to prepare the Forest Service with the information needed to determine if the C-27J could be used to fulfill the Forest Service mission, should an inter-governmental transfer of aircraft occur. The C-27J is specifically configured to meet DoD requirements, and in some cases, the addition of DoD equipment or DoD selected options has changed the manufacturer's specifications and capabilities (e.g. capacities and the weight of the aircraft). Some of these DoD modifications include the addition of the standardized cargo compartment locking rail and roller cargo loading system, the replacement of the manufacturer's passenger seating with a reduced seating package, and the installation of flight deck protective armor. Convergent has noted the applicable differences in the data when a discrepancy exists between the current US configuration and the manufacturer's stock configuration. Where appropriate, Convergent has noted the manufacturer's specification if retrofitting is anticipated or if alternate manufacturer equipment options are better suited for Forest Service mission and could be included.

C-27J Capabilities

General specifications and performance data are listed in the following tables with definitions, amplifying remarks and caveats included as footnotes. This specification and capability information is designed to provide the basic architecture for discussion throughout the analysis.

Aircraft Features

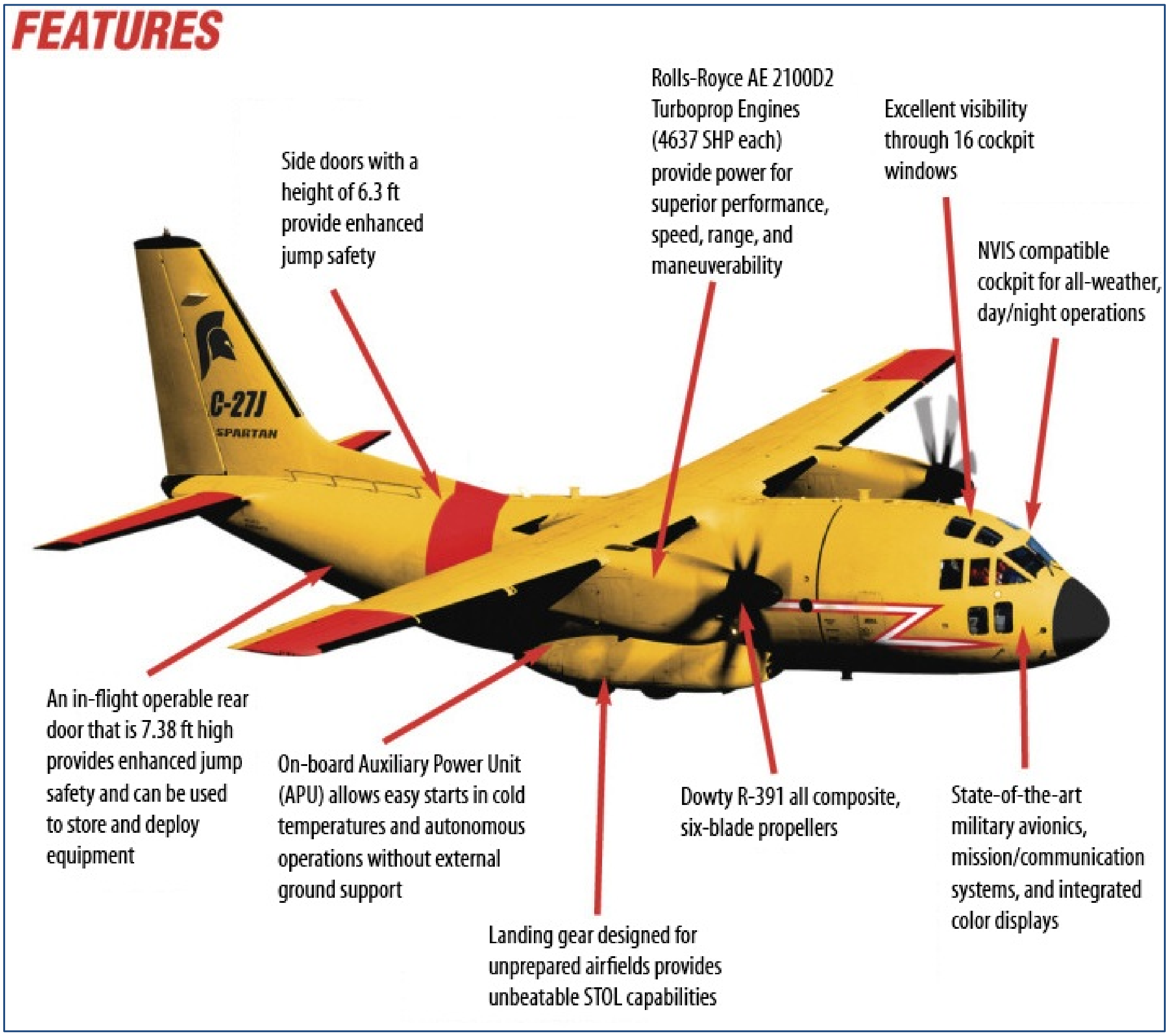


Figure 2 C-27J Features

Aircraft Dimensions

Length	74' 8"
Height	31' 8"
Wingspan	94' 2"
Ground Clearance	3' 11"

Table 1 C-27J Dimensions

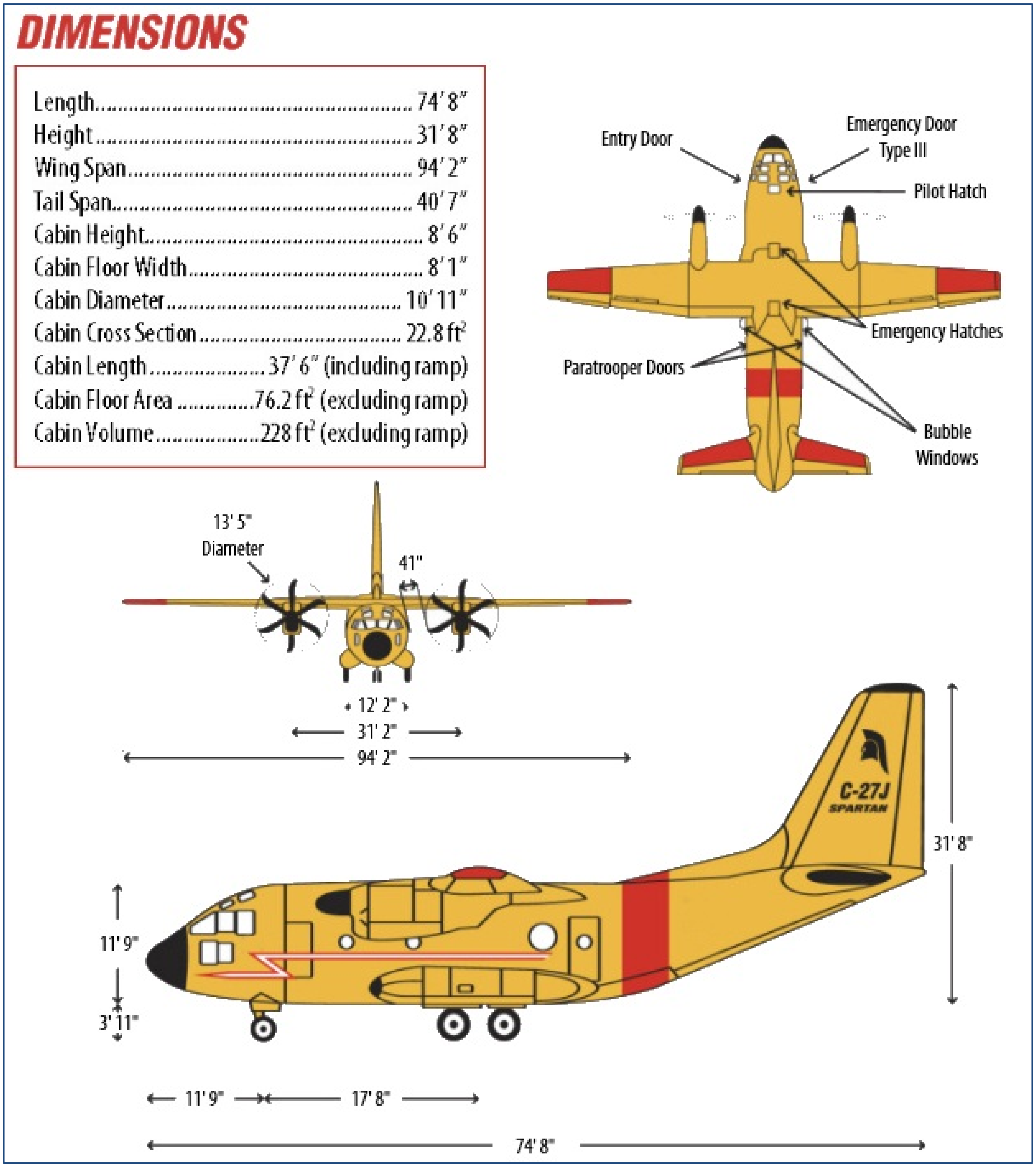


Figure 3 C-27J Dimensions

Performance, Specifications and Equipment

Power Plant

The C-27J is a twin-engine turbo prop style aircraft. The installed engine and associated drive components are the exact engine and propeller used on the Lockheed Martin C-130J, operated by agencies all over the world in all types of conditions. The engine is proven to be reliable, durable, and easily maintained. Additionally, a by-product of a large number of C-130J aircraft in service and a diverse list of agencies operating with this engine is the assurance of an active power plant parts supply chain.

Engine	
Manufacturer	Rolls Royce
Model	AE2100D2A
Type	Dual-rotor, free-turbine power section with a propeller gearbox
Maximum Continuous Power	4,637 HP[1]
Fuel Burn	Cruise: 2,200 lbs / hour Mission: 2,800 lbs / hour
Propeller	
Manufacturer	Dowty
Model	R391
Type	Six-blade, coarse seeking counter-weight design, variable pitch composite propeller

Table 2 C-27J Engine Description

[1] Maximum continuous horsepower rating is 4,637 ± 74 horsepower, flat rated out to 28 ˚C and the maximum takeoff horsepower performance rating is 4,637 ± 74 horsepower, flat rated out to 39 ˚C.

Weights

Maximum Takeoff Weight	67,241 lbs
Maximum Landing Weight	67,241 lbs[2,3]
Operating Empty Weight	46,200 lb[4]
Fuel Capacity	3,255 gal or 22,134 lbs[5]
Maximum Payload (Cargo & Fuel)	21,041 lbs[6,7]
Maximum Cargo Payload: Full Fuel Load	0 lbs[8]
Maximum Cargo Payload: 2.5 hr Fuel Load	15,222 lbs[9]
Maximum Zero Fuel Weight	58,422 lbs[10]

Table 3 C-27J Aircraft Weight Limitations

[2] 67,241 is the maximum landing weight, but requires a restriction for landing of no greater than 6 fps sink rate due to structural limitation. Repeated landing at this weight has no adverse effect on the aircraft's service life and requires no additional maintenance action.

[3] 60,627 is the maximum landing weight under normal landing conditions of 10 fps sink rate (3-degree glidepath).

[4] Operating empty weight is defined as the sum of basic weight plus crew, crew baggage, emergency equipment, and other nonexpendable items not in the basic weight. It is equivalent to takeoff gross weight less usable fuel, cargo payload, mission items. The manufacturer's published operating empty weight is 38,581 lb; however, this weight has not been seen on any aircraft and the manufacturer has not been able to successfully defend this value to US flight test crews. The DoD calculated value is significantly higher due to additional equipment and is a verifiable weight of 46,200 lbs. Operating empty weight may be reduced by removing equipment not required by the Forest Service [e.g. cockpit protective armor panels (1,100 lbs); miscellaneous equipment such as tie downs and litters (1,000 lbs); and the cargo loading system (1,200 lbs). The most likely operating empty weight for the Forest Service is 44,100 lbs with the aircraft with cockpit armor and miscellaneous equipment removed.

[5] A maximum fuel weight of 22,134 lbs is based on a physical capacity of 3,255 US gallons of Jet A and Jet A1 with a nominal weight of 6.8 lbs/gal and is the value used for calculations in this assessment. The C-27J is capable of using many different military grade fuels as well as alternate/emergency fuels such as AVGAS. With the DoD operating empty weight of 46,200 lbs only 21,041 lbs of fuel capacity is available without exceeding maximum takeoff weight.

[6] See footnote 5.

[7] With the DoD operating empty weight of 46,200, the maximum cargo payload, without exceeding the maximum zero fuel weight is limited to 12,222 lbs. In this case, the cargo payload is restricted below the maximum allowed due to wing root bending moment restrictions. Cargo weight can be increased above 12,222 as fuel is added to the wing tanks. The generally accepted rule of thumb is a pound-for-pound increase in cargo for fuel up to the maximum takeoff weight resulting in approximately 16,422 lbs or cargo and 2 hours of fuel. The manufacturer has not provided a definitive formula for this process and the USAF has restricted the cargo weight, possibly in lieu of the complexity of cargo vs. fuel planning.

[8] See footnote 5.

[9] See footnote 7.

[10] The maximum zero fuel weight is the maximum weight allowed before usable fuel and other specified usable agents are loaded in defined sections of the aircraft as limited by strength and airworthiness requirements. 58,422 lbs is the maximum zero fuel weight for aircraft operations up to 2.5 Gs (2.5 to 3.0 G flight is restricted to 57,320 lb).

Performance and Flight Characteristics

The following table provides basic aircraft dimensions, capacities, equipment and typical performance data for the C-27J with its current DoD configuration and weight.

Maximum Speed	325 TAS	
Cruise Speed	315 KTAS[11]	
Maximum Range	**Ferry (empty)[12]**	3,100 nm
	12,222 lb payload[13]	1,300 nm
	14,422 lb payload[14]	700 nm
Airdrop/Paradrop Speed	110 – 130 KIAS	
Approach Speed (MLW)	133 KIAS	
Stall Speed (Landing Gear and Flaps Retracted)	**Maximum Takeoff Weight**	126 KIAS
	Aircraft Gross Weight 45,000 lbs	101 KIAS
Stall Speed (Landing Gear and Flaps Extended)	**Maximum Landing Weight**	97 KIAS
	Aircraft Gross Weight 45,000 lbs	79 KIAS
Ceiling	30,000'[15]	

[11] The cruise speed of 315 KTAS is based on maximum gross weight at cruise. Maximum speed is 325 KTAS.
[12] Ferry is based on a full fuel load of 21,041 lbs for the DoD configured aircraft with a 46,200 lb operating empty weight. The manufacturer claims a range of 3,200 nm for an aircraft with an operating empty weight of 38,353 lbs
[13] Cargo payload of 12,222 lbs is derived from the maximum cargo load available without exceeding maximum zero fuel weight with a fuel load up to maximum takeoff weight (8,819 lbs). This scenario is based on not adding allowable cargo weight over maximum zero fuel weight limits when fuel is added relieving wing root bending moment restrictions. By not exceeding maximum zero fuel limits all fuel on board is available to consume in flight. The manufacturer claims 2,300 nm for an aircraft with an operating empty weight of 38,353 lbs.
[14] 14,422 lbs of cargo represents a value where 2,200 lbs of cargo was added above the zero fuel weight limiting 12,222 lb cargo load when fuel was added. This scenario requires the aircraft to land with a minimum of 2,200 lbs of fuel in order to not exceed the zero fuel weight which renders the fuel unusable for range and acts as ballast only. If 4,400 lbs of cargo were added to the 12,222 lb zero fuel limiting cargo load for a cargo load of 16,622, additional fuel is required to offset the wing root bending moment issue, but the end result in range would be 0 nm since the aircraft must land with all of its fuel as ballast.

Engine Out Ceiling	14,500'[16]
Takeoff Run (MTOW)	1,903'[17]
Takeoff Distance Over a 50' Obstacle (Maximum Takeoff Weight)	3,750'
Rate of Climb at Sea Level (ISA / 70°F)	2,450 fpm
Rate of Climb at 5,000' MSL (ISA+25 / 70°F)	1,750 fpm
Landing Roll (Maximum Landing Weight)	1,115'[18]
Landing Distance from Over a 50' Obstacle (Maximum Landing Weight)	1,200'
Taxi Turn Radius	56' 1"

Table 4 C-27J Aircraft Performance and Flight Characteristics

[15] FAA certification for aircraft with a single air conditioning/pressurization pack system is restricted to 25,000' MSL. Although the aircraft is capable of 30,000' MSL, operation by the Forest Service would be limited to 25,000' MSL under current FAA operating constraints.

[16] Single engine service ceiling is based on the critical engine inoperative and propeller feathered with the aircraft operating at 95% of the maximum takeoff weight at ISA conditions.

[17] The takeoff ground run represented is the minimum ground run for a maximum performance takeoff (tactical procedures) at the maximum takeoff weight and ISA conditions for Sea Level.

[18] The landing ground roll is based on the minimum landing ground roll at maximum normal landing weight (60,627 lbs / 10 fps sink rate) and ISA conditions for Sea Level. Landing at above 60,627 lbs up to 67,241 lbs is possible, but not normally accomplished and is restricted to a maximum sink rate of 6 fps.

Crew Requirement

Pilots	2[19]
Loadmasters	1[20]

Table 5 C-27J Minimum Aircrew Required

Personnel Carrying Capacity

Maximum Passengers	68
Maximum Parachutists	46
Maximum Ambulatory Passengers	21 litters + 12 attendants[21]

Table 6 C-27J Aircraft Personnel Capacity

[19] In addition to the pilot and co-pilot seat, an additional observer seat is located in the cockpit. The C-27J cannot be flow as a single pilot platform.

[20] Depending upon selected operating procedure, some missions may not require a loadmaster. The manufacturer has listed the minimum crew as only two pilots; however, the USAF considers the minimum crew as two pilots and one loadmaster

[21] Although none of the current Forest Service missions have a need for ambulatory passenger transport, the information is provided as information only as a capability of the aircraft as it would be received from DoD. This information also represents equipment that could be removed from the aircraft mission equipment in order to lower the current DoD operating empty weight of 46,200 lbs.

Communication

V/UHF Radios	4 integrated radios Manual backup control
APCO-25 Public Service Radios	2 radios Manual frequency selection PC database data port Forest Service requirement already installed
HF Radios	1 integrated radio Automatic link establishment
INMARSAT SATCOM	Satellite data unit High speed data unit High power amplifier Diplexer/low noise amplifier High gain antenna

Table 7 C-27J Communication Equipment

Navigation

Embedded Global Positioning/Inertial Navigation System (EGI) GPS	Dual embedded receivers
Communication/Navigation/Instrument-Mission System	Completely integrated Flight Management System (FMS)
VHF Omnidirectional Range / Instrument Landing System / Marker Beacon (VOR/ILS/MB)	Dual embedded receivers
TACAN	Dual embedded receivers
V/UHF Direction Finder (DF)	Dual embedded receivers
Automatic Direction Finder (ADF)	Dual embedded receivers
IFF Transponder	Integrated with communication equipment

Table 8 C-27J Navigation Equipment

C-27J and Forest Service Mission Complement

Figure 4 Forest Mission

The C-27J is a very capable cargo, personnel and aerial delivery platform. The following subsections and associated tables provide factual discussion of the capabilities as they may meet, improve, or reduce the capabilities of each Forest Service aviation mission represented.

Air Tanker

The C-27J was designed for airdrop and low-level flying. Its heads up display (HUD), navigation suite, high-wing design, turn and climb performance, ability to handle 3-G turns and pull-ups, as well as the aft cargo door/ramp delivery system, appear to make the C-27J a very realistic candidate for air tanker operations. The C-27J's civil predecessor, Alenia's' G222 (C-27A) aircraft, has previously demonstrated the capability to perform as an air tanker with a retardant capacity up to 1,800 gallons. This type of system could possibly be adapted to the C-27J, though based on additional weight for the system components and applied maximum zero fuel weight limitations the manufacturer has placed on the C-27J, the capacity would be much lower than the 2,000-gallon minimum desired by the Forest Service for a medium tanker role. Depending on the type of system and the weight of the installation, the C-27J could possibly be configured to carry up to 1,850 gallons of retardant with 2.5 hour of fuel on board. This estimate takes into account several assumptions:

- The aircraft operating empty weight must be reduced to 42,900 lbs by removing the following unnecessary equipment:
    - Flight deck armor (approximately 1,100 lbs)
    - Miscellaneous mission equipment such as litter stanchions, tie-down chains, ladders, etc. (approximately 1,000 lbs)
    - Cargo loading system (approximately 1,200 lbs)

- The aircraft would likely have to be dedicated to the air tanker role without the load/unload capability normally available with the cargo loading system installed.
- The system components could not exceed 10% of the total weight of the system including the weight of the retardant.

Another concept possibility that deserves further consideration would be the concept applied with the Mobile Airborne Fire Fighting System (MAFFS) system currently in use on Air National Guard and Air Force Reserve C-130 aircraft. The C-27J cannot use the MAFFS in its current form due to physical dimension and weight, but could possibly employ a newly designed version of the system specifically for the C-27J. The current MAFFS weighs approximately 14,000 lbs empty, carries 3,000 gallons (26,700 lbs) of retardant, and occupies five pallet positions, exceeding the C-27J's limitations by 22,000 lbs and two pallet positions. A smaller, similar system could take advantage of the C-27J's locking rail cargo and delivery system, and a similar aft cargo door/ramp used for the palletized MAFFS II. The C-27J however, has a smaller diameter fuselage and must rotate the 108" x 88" (463L) pallet 90 degrees from the traditional position used by C-130 aircraft. This concept, although tried and proven requires a heavy system to deliver a reduced retardant load. A mini-MAFFS design for the C-27J is estimated to be 7,000 to 8,000 lbs without retardant. This would leave room for approximately 1,100 gallons (9,700 lbs) of retardant with 2.5 hours of fuel on board the aircraft. This estimate takes into account the following assumptions:

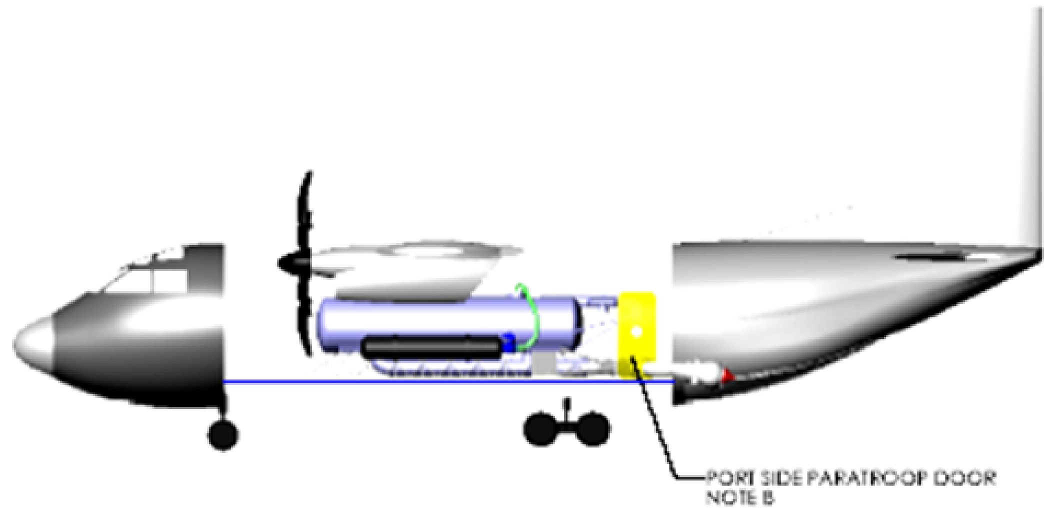
- The aircraft operating empty weight must be reduced to 44,100 lbs by removing the following unnecessary equipment:
    - Flight deck armor (approximately 1,100 lbs)
    - Miscellaneous mission equipment such as litter stanchions, tie-down chains, ladders etc. (approximately 1,000 lbs)
- The aircraft cargo loading system remains installed to support the MAFFS concept
- The system components do not exceed 8,000 lbs
- The new design would likely not include an onboard compressor system which requires additional aircraft electrical load consideration

Finally, a constant flow type delivery system presents another possibility. Several constant flow delivery systems have been used in the past, many successfully. A constant flow delivery system usually requires some modification to the aircraft including the installation of significant external delivery components attached to the bottom of the fuselage. A new design version of a constant flow delivery system tailored specifically for the C-27J could take advantage of the aircraft's design and eliminate the need for large external components and could feature internal or external components avoiding major modifications. Any external design would have to take into consideration the 3'11" fuselage ground clearance on the C-27J. A constant flow delivery system using internal cargo compartment retardant storage could be designed to use the cargo loading system that allow the system to be removed so the aircraft could be used for multiple roles, but would likely reduce retardant capacity due to the additional weight of the cargo loading system. If the aircraft were dedicated to the air tanker role, the estimated capacity could be as high as 1,850 gallons with 2.5 hours of fuel on board. This estimate takes into account the following assumptions:

- The aircraft operating empty weight must be reduced to 42,900 lbs by removing the following unnecessary equipment:

  - o Flight deck armor (approximately 1,100 lbs)
  - o Miscellaneous mission equipment such as litter stanchions, tie-down chains, ladders etc. (approximately 1,000 lbs)
  - o Cargo loading system (approximately 1,200 lbs)
- The aircraft would likely have to be dedicated to the air tanker role without the load/unload capability normally available with the cargo loading system installed.
- The system components could not exceed 10% of the total weight of the system including the weight of the retardant.

The G222 style, MAFFS and constant flow delivery system concepts all require additional research and testing to determine compatibility and modification requirements. On the surface, all three optimistically remain viable air tanker options; however, the overall retardant carrying capacity is not likely to meet Forest Service expectations without the manufacturer providing relief from the limiting maximum zero fuel weight. The aircraft has more powerful engines and more efficient propellers, and greater structural strength than its predecessor, yet it appears to be more limited when it should be exceeding the G222 (C-27A) capabilities.



C-27J with Conceptual MAFFS Installed (Concept Reference Only)

Figure 5 C-27J MAFFS Concept Depiction

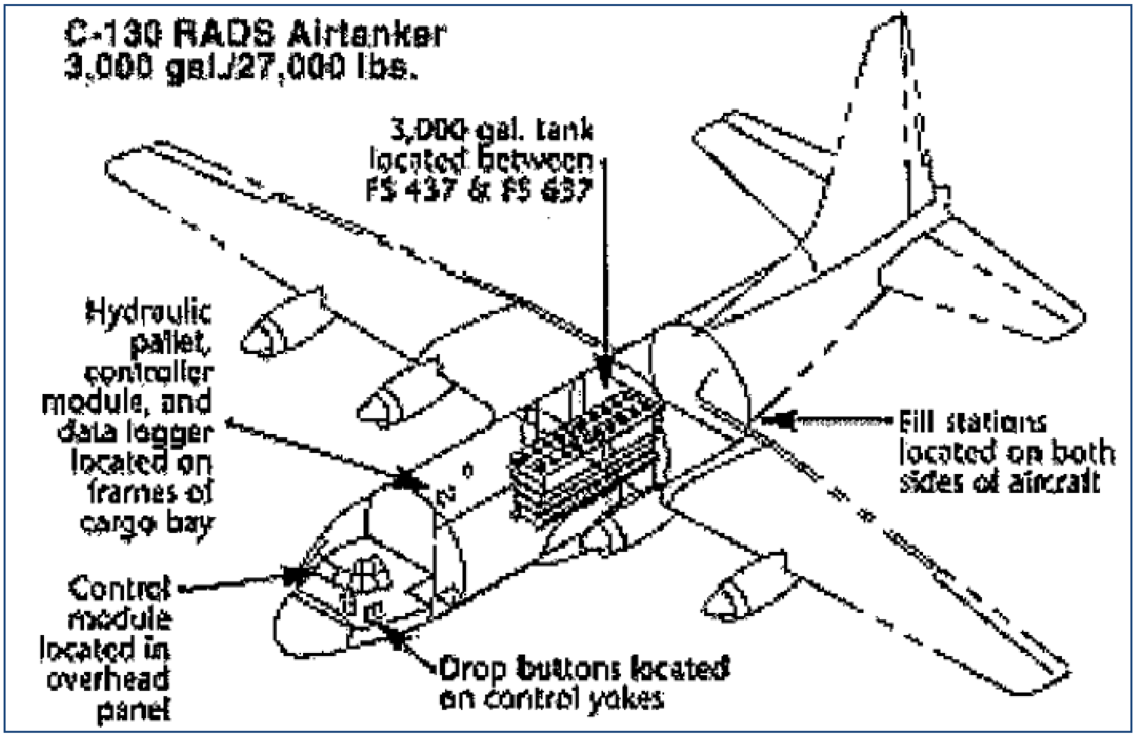


Figure 6 Constant Flow Delivery System Depiction

Figure 7 G222/C-27A Retardant Delivery

Smoke Jumper Mission

The C-27J aircraft is very compatible with the smoke jumper mission. The aircraft is specifically designed as an aerial delivery platform for personnel as well as cargo. The C-27J is a high wing aircraft keeping the disruptive airflow above the jump platform; a distance of 41” between the propeller and fuselage to keep turbulence well away from the jumpers; and a horizontal stabilizer on the tail that sits well above the jumper path practically eliminating any parachute contact. The high wing design and the cockpit’s 16-windows provide the best conditions for air to ground visibility and the robust avionics suite with HUD allows pinpoint GPS accuracy for each airdrop. The side doors have a very safe and comfortable height of 6’ 4” and the rear door opening is 7’ 5” high. Free-fall jumpers can be deployed from either side door exit or from the aft ramp. Static line jumpers can only be deployed using the side door exits.

Figure 8 Static Line Operations

Figure 9 Ramp Operations

Maximum Jumper Capacity	46[22,23]	
Jump Platform/Exits	Side exit doors[24,25,26] Aft ramp exit[27]	
Exit Height	Side exit doors: 6' 4" Aft ramp exit: 7' 5"	
Jump Systems Supported	Static line and free-fall[28]	
Aircraft Airdrop Speed	**Maximum**	130 KCAS
	Minimum	100 KCAS[29]
	Normal range	110 – 130 KCAS[30]
Aerial Delivery System	Fully integrated flight management computer with airdrop navigation and sequence interface	
Maximum Individual Jumper Weight	350 lbs	

Table 9 C-27J Smoke Jumper Compatibility

[22] The manufacturer offers seating equipment for configurations up to 46 jumpers and 2 loadmasters. The 46-jumper capability is based on 20" MIL-S-27174B (military standard 20" seat spacing). The seating equipment required for 46 jumpers does not meet DoD desired configuration and is not part of the current US aircraft configuration.

[23] The current US configuration can accommodate up to 34 jumpers without combat equipment and up to 24 fully equipped jumpers and is based on a seating configuration of 24" seat spacing with no center seats or seat supports installed.

[24] The C-27J is equipped with right/left side exit doors located behind the wing in the aft cargo compartment. These doors are designated and specifically designed by the manufacturer for personnel airdrop. The C-27J is conveniently equipped with communication and airdrop indication/status panels next to each door, and each door is equipped with an airstream deflector and jump platform which, when installed in flight, extends out the side door providing proper jumper position, stability and safety. The aircraft is also equipped with a hung jumper retrieval system for jumper rescue/recovery following a static line malfunction.

[25] The C-27J airdrop system is designed for and capable of palletized cargo airdrop and personnel free-fall airdrop from the aft ramp.

[26] Cargo bundles with a maximum weight of 500 lb each may be airdropped from either side door.

[27] Static line operations can only be conducted from the paratroop doors on the left/right aft side of the aircraft. Static line operations are not functional from the open rear ramp. The manufacturer does not recommend simultaneous static line operations from both the left and right doors. The aft ramp and either side paratroop doors may not be in the open position simultaneously during flight preventing cargo and static line airdrop on the same delivery run-in.

[28] See footnote 27.

[29] The minimum airdrop speed is based on the minimum speed for ramp, cargo door and side jump door operations in flight, which is 100 KCAS or 1.15 V_S whichever is greater.

[30] Personnel airdrop airspeed is a component of aircraft gross weight and is normally 110 KCAS or 1.2 V_s (whichever is greater) to 130 KCAS.

Cargo Transport Mission

The C-27J is easily capable of delivering time-sensitive cargo, supplies and personnel to operating locations in a “last mile forward” role. It can efficiently haul cargo in and out of remote austere locations with its short takeoff and landing capability. The performance in and out of these fields is impressive for an aircraft in its weight class as it has the performance of a much lighter aircraft and a much higher cargo capacity; however, the C27J has a lower than expected maximum zero fuel weight caused by wing root bending moment issues. This restricts the cargo weight to 12,222 lbs in order to not exceed the aircraft’s maximum zero fuel weight of 58,353 lbs, and then the cargo weight can only be increased as fuel is added to the wings. This can become problematic since the fuel added to increase cargo payload cannot be used unless the cargo is airdropped, otherwise the aircraft would exceed the maximum zero fuel weight as the fuel is burned.

Figure 10 Austere Takeoff

Figure 11 Bundle Airdrop

Figure 12 Cargo from Aft Ramp without Center Seats

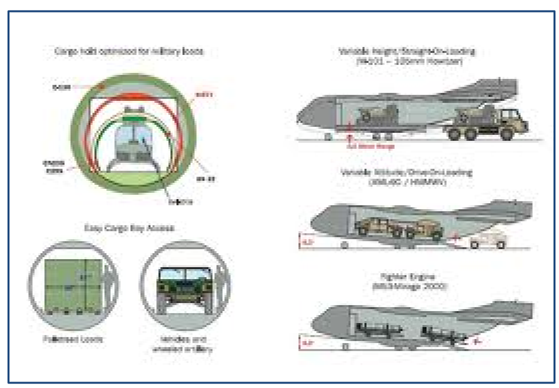


Figure 13 Loading Configuration

Figure 14 Drive-in / Drive-out

All the strengths that make the C-27J a good smoke jumper platform transfer directly to its strengths as a cargo airdrop platform. The C-27J has all of the design qualities to put cargo anywhere, day or night.

Cargo Loading System Type	Palletized locking rail and roller[31,32] Drive-in/drive-out[33] Static floor load[34]
Maximum Cargo Capacity	Weight: 21,041 lbs[35] Height: 7' 4" Width: 8' 0" Length: 28' 1" Pallet positions: 3

[31] Three pallet position rail and lock system identical to C-130 military delivery system and uses the same HCU-6/E (463L) cargo pallet (108" x 88"). It is important to note the C-27J aircraft employs the cargo pallet turned 90 degrees from traditional cargo aircraft. The C-27J orients the 88" side as the forward and rear edge and the 108" side as the left and right side of the pallet.

[32] The cargo loading system is the same system used by most US government cargo facilities (Forklifts and K-loaders).

[33] A ramp and aircraft leveling system provide reduced angle drive-on/drive-off capability for many vehicles and a dual equipment winching system to allow roll-on/roll-off loading of un-motorized wheeled vehicles/equipment.

[34] Static floor loading and tie-down may be accomplished with hand-loaded cargo or forklift loading using the aft ramp.

[35] 21,041lb maximum cargo capacity is based on DoD configuration of 46,200 lb operating empty weight. The manufacturer lists the maximum cargo weight as 25,353 lbs for a 38,581 lb operating empty weight.

Maximum Palletized Cargo Dimensions	83" height x 88" width[36]
Cargo Airdrop	Aft ramp: Palletized cargo aerial delivery system and CDS bundles Side doors: CDS bundles
Maximum Airdrop Cargo Dimensions	Aft ramp delivery: 83" height x 88" width x 108" length[37] Side jumper door delivery: 48" long, 30" wide, 66" high[38]
Cargo Loading Support Equipment	Palletized cargo loader (K-loader), forklift, roll-on/roll-off, hand load and drive-on/drive-off compatible[39]
Cargo Compartment Floor Area	226.28 sq ft
Usable Cargo Compartment Volume	2,049 cu ft[40]

Table 10 C-27J Cargo Compatibility

[36] See footnote 31.
[37] See footnote 31.
[38] Dimension height includes parachute.
[39] The cargo area houses a total of 85 tie down rings (10,000 lb rated capacity), arranged in a 20 inch by 20 inch symmetrical pattern grid. Tie down rings can be rotated 360° and when not in use, are recessed in the floor. In addition, 30 rings (15 on each side) are installed on the sides of the main cargo area.
[40] 2,049 cu ft is the sum of the cargo compartment and ramp (1675 + 374). The ramp can be used to load additional equipment (5,000 lb rated capacity).

Passenger Transport

The C-27J performs well for passenger transport. With a pressurized cargo compartment, passengers can remain off supplemental oxygen though oxygen is available at each seat. The C-27J utilizes side web seating with an optional center row allowing for several derivations/configurations to accommodate a mix of passengers and cargo.

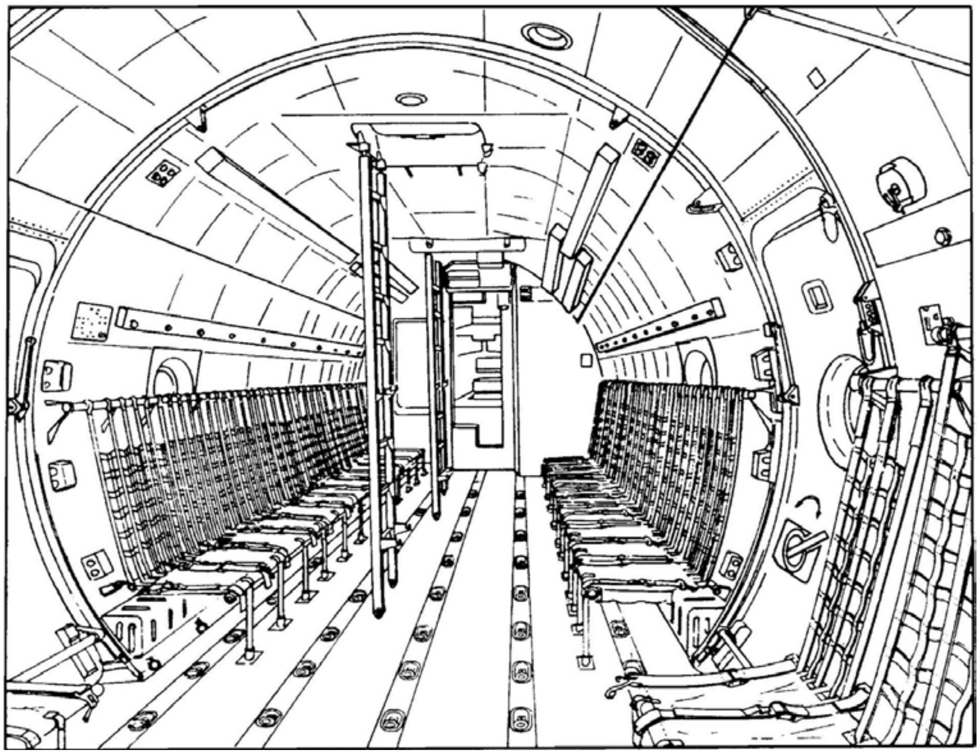


Figure 15 C-27J Web Seating[41]

Passenger capacity	68[42],

Table 11 C-27J Passenger Capacity

[41] Passenger capacity of the web seats is 9G.

[42] The aircraft configuration can be changed and fitted with standard outer and center side seating to accommodate 68 passengers with limited personal equipment + 2 loadmasters. The seat configuration and seat size requirement for passengers is not the same configuration and size required for parachute jumpers The manufacturer also offers airline type passenger seating packages that include hard sidewalls and fixed floor seating, which don't allow for conversion to and from cargo/jump operations. The potential to develop removable palletized VIP style seating is highly probable.

Performance Scenarios

The Forest Service has identified several case-study airfields to test the C-27J performance. Landing performance into the airfields is not limiting; therefore, only takeoff data is presented for the mission-oriented load presented. When a maximum performance takeoff is required, "tactical" takeoff procedures are used. "Tactical" procedures are similar to short field takeoff (STOL) type procedures that take advantage of takeoff and climb ratios closer to stall speed than normal takeoff procedures. Tactical procedures assume additional risk and may require takeoff prior to being at a safe single engine speed or "split markers". The data is presented in a color coded format where "green" represents data acceptable for takeoff, "red" represents data not acceptable for takeoff, and "yellow" represents the data where additional risk must be accepted, but takeoff is possible.

Two types of performance scenarios and data are presented in this section. First, a "last mile forward" scenario is presented where a single C-27J aircraft would be dispatched to pick up two standard fire crews of 20 personnel and light gear (5,300 lbs total for each crew) and insert them into a forward area field or have the aircraft dispatched to the forward field to retrieve the same load and transport them to another location. The fields requested by the Forest Service for sampling are Alturas Municipal Airport, CA (KATT); Reserve Airfield, NM (T-16); and Negrito Airstrip, NM (0NM7). All three of these fields are consistent with those that would give the Forest Service a tactical advantage being able to insert fire crews and immediate-need equipment on the front line or the "last mile forward." The C-27J performance from Reserve Airfield, NM, is marginal in most cases for two fire crews so additional data is presented for just a single fire crew of 5,300 lbs.

Last Mile Forward Scenario Data

The manufacturer's performance publications present V_1/V_R ratios as low as 0.8 and introduce an increased risk in takeoff operations based on the possibility of an engine failure occurring after V_1 and prior to V_R. For these scenarios, Acceleration Stop Distance is calculated using a safer V_1/V_R ratio of ≥ 1.0. Lowering the V_1/V_R ratio will reduce Acceleration Stop Distance; however, an increase Ground Run Critical Engine Inoperative Distance will result. If operating in this regime consideration should be given to a short duration second segment and prolonged third segment climb. If the user chooses to accept the risk and operate using $V_1/V_R < 1.0$, there is greater opportunity to use the C-27J into and out of an increased number of austere and "last mile forward" airfields.

Alturas Municipal Airport, California (KATT)

Delivery operations into Alturas Municipal are not restrictive at any temperature. The best takeoff performance is for runway 31. Normal takeoff operations with a fire crew and gear are unaffected below 30˚C for runway 31 and below 25˚C for runway 13. A "tactical" takeoff assumes slightly more risk, but is possible with the same load for all runways below 40˚C.

See Appendix A for scenario data.

Reserve Airport, New Mexico (T16)

Delivery operations into Reserve Airport are not restrictive at any temperature. For the first scenario, the best takeoff performance is for runway 06. Normal takeoff operations with a fire crew and gear are unaffected below 20˚C for runway 06. A “tactical” takeoff assumes slightly more risk, but is possible from all runways with the same load and all conditions below 30˚C and V_1/V_R of 1.0. A V_1/V_R of < 1.0 is supported in the manufacturer’s performance data, but assumes more risk in the case of an engine failure on takeoff. With a V_1/V_R ratio < 1.0, takeoff with the same load is possible from all runways below 38˚C.

For the second scenario, where the load is reduced to just the 4,500 lbs of equipment or the equivalent weight in passengers (22 passengers), normal takeoff is available for runway 06 up to 30˚C and for runway 24 up to 20˚C. Above these temperatures, the same argument for “tactical” takeoff procedures exists as in the first scenario with the exception that operations with a V_1/V_R of 1.0 are extended into higher temperature ranges for both runways.

See Appendix B for scenario data.

Negrito Airstrip, New Mexico (0NM7)

Delivery operations into Negrito Airstrip are not restrictive at any temperature. Runways 17/35 provide the best takeoff performance; however, normal takeoff operations with a fire crew and gear are not possible from any runway at Negrito. A “tactical” takeoff assumes slightly more risk, but is possible with the same load for runways 17/35 below 33˚C with a V_1/V_R ratio of 1.0. A V_1/V_R ratio of < 1.0 is supported in the manufacturer’s performance data, but assumes more risk in the case of an engine failure on takeoff. With a V_1/V_R ratio < 1.0, takeoff with the same load is possible from all runways below 34˚C.

See Appendix C for scenario data.

Lifecycle Costs

The lifecycle costs analysis was completed and is presented as a comparison for three separate terms: 20, 25 and 30 years. The analysis was also completed with two separate utilization scenarios: 250 flight hours per aircraft annually and 400 flight hours per aircraft annually. The most likely basing and maintenance operations model was chosen for the analysis which includes two geographically separated bases with seven assigned aircraft each; and takes advantage of economies associated with centralized and concentrated maintenance resources and is representative of what could be considered for a fleet with a singular air tanker or "last mile forward" mission role. If the aircraft were utilized solely for a smoke jumper mission role, it is likely a more distributed basing model with decentralized maintenance and duplicated infrastructure would be required to ensure a more responsive and ready-state fleet, but would likely present greater fixed costs.

The analysis is based on the current DoD aircraft changing ownership "as is" with the existing equipment remaining intact in its current location on the aircraft. Convergent cannot determine the cost to the Forest Service for removal of DoD equipment or Forest Service desired changes in configuration whether removing existing equipment or purchasing and installing additional manufacturer equipment options.

Convergent accomplished thorough research and analysis to provide the most accurate data, though this required non-disclosure agreements with several sources. Only total costs are presented to avoid violating any of the non-disclosure agreements, proprietary information agreements, or conflict of interest scenarios that may result should requests for proposal be placed related to future C-27J contract work. Some of the specific values used in the cost calculation estimates are listed in the assumptions section following the Lifecycle Costs and Comparisons section below. The itemized categories considered in determining the fixed and variable costs in the analysis include, but are not limited to:

- Aircrew salaries
- Additional aircrew costs associated with off-station operations
- Maintenance salaries
- Managerial employees
- Employer's additional employee costs and responsibilities
- Infrastructure (e.g. hangar, office, maintenance, parts distribution facilities and utilities)
- Aircrew/jumper training (initial qualification and recurrent training adjusted for attrition)
- Maintenance training
- Computerized maintenance management system costs
- Navigation and weather support services
- Aircraft refurbishment and paint
- Aircraft modernization
- Aircraft washing and corrosion mitigation
- Aircraft flight generation support equipment and associated scheduled maintenance.
- Aircraft parts (including estimates for parts with high replacement rates such as tires)
- Scheduled programmed interval maintenance and inspections

- Major component and airframe overhaul maintenance (e.g. propeller, landing gear, power plant overhauls)
- Consumables (Fuel, fuel additives, lubricants, oxygen, etc.)

Convergent did not include adjustments for projected inflation or aircraft depreciation schedules or recapitalization payments normally applied by the Forest Service's Working Capital Fund (WCF). The assumptions and variables considered in the lifecycle calculations follow the tables in this section.

Lifecycle Costs and Comparison

400 Hours per Aircraft Annually

	20 year	25 year	30 year
Life cycle cost per individual flight hour	$5,862	$5,849	$5,844
Cost per individual flight hour (fuel and consumables only)	$3,100	$3,100	$3,100
Total lifecycle cost per aircraft	$46,894,911	$58,492,203	$70,130,249
Total lifecycle fleet variable costs	$420,228,760	$525,660,840	$631,243,480
Total lifecycle fleet fixed costs	$236,300,000	$293,230,000	$350,580,000
Total lifecycle fleet cost	$656,528,760	$818,890,840	$981,823,480

Table 12 Lifecycle Costs (400 Hour Model)

250 Hours per Aircraft Annually

The lifecycle cost per individual flying hour is nearly 23% higher for the 250-hour utilization rate versus the 400-hour utilization rate, whereas the overall lifecycle costs for the entire fleet is nearly 21% less.

	20 year	25 year	30 year
Life cycle cost per individual flight hour	$7,491	$7,471	$7,462
Cost per individual flight hour (fuel and consumables only)	$3,100	$3,100	$3,100
Total lifecycle cost per aircraft	$37,453,911	$46,690,953	$55,968,749
Total lifecycle fleet variable costs	$288,054,760	$360,443,340	$432,982,480
Total lifecycle fleet fixed costs	$236,300,000	$293,230,000	$350,580,000
Total lifecycle fleet cost	$524,354,760	$653,673,340	$783,562,480

Table 13 Lifecycle Costs (250 Hour Model)

Assumptions:

1. Aircraft are transferred from the Department of Defense to the Department of Agriculture with zero acquisition costs to the Forest Service.
2. All amounts are considered 2012 US dollars. Out year figures were not adjusted for inflation.
3. All calculations were based on a 14 aircraft fleet based at 2 locations (7 aircraft at each base) and are modeled on 400 hours per aircraft annually and 250 hours per aircraft annually. They also account for aircraft manufacturing dates varying from 2010 to 2013 and a range of aircraft accumulated hours at estimated time of transfer to the USDA Forest Service of 1,500 hours for the oldest aircraft and 0 hours for the newest.
4. Aircrew salaries are expected to be contracted rates; however, calculations are based on equivalent government schedule (GS) salaries for comparable positions (Supervisors: GS 14; pilots: GS 12 and GS 13; co-pilots: GS 11; and loadmasters: GS 9 and GS 10).
5. Maintenance personnel salaries are expected to be contract maintainer rates; however, calculations are based on equivalent government schedule (GS) salaries for comparable positions (Supervisors: GS 14; Specialist: GS 11; Mechanics: GS 10; refuelers/crew chiefs: GS 9).
6. Personnel cost calculations also account for additional employer personnel costs using pre-tax salaries plus a factor of 28%.

7. Aircrew training costs are calculated using an annual personnel attrition rate of 20% and are based on the current US Air Force syllabus provided by the only C-27J training program in North America.
8. Additional ancillary aircrew costs (per diem, lodging, etc.,) include a rate equivalent to $47.00 per flight hour per aircraft.
9. Aircraft fuel is calculated using OEM recommended Jet A+ at a rate of $6.65 per gallon. This value is conservative and is used to show maximum costs based on worst-case purchase conditions. Factors such as decreases in crude oil prices, supply volumes, availability of government contract fuel and point of service factors will likely reduce these costs.
10. Crew calculations are based on a ratio of 1.5 per aircraft. This ratio is has been calculated as adequate to cover all USDA Forest service aircraft/aircrew applications.
11. Lease costs for a single national parts distribution warehouse are included in the fixed cost calculation, but do not account for personnel/manning of the facility.
12. WCF was not included in any of the calculations due to the uncertainty of whole or partial requirements or relief. WCF considerations must be determined and then added before considering total cost.
13. Cost calculations made using maintenance models were based on FAA requirements and the planning utilization rate of 400 hours and 250 hours per aircraft annually; and engine and airframe cycles of 1.0 per flight hour based on perceived aircraft employment.
14. Hangar facilities are based on a single, size appropriate maintenance hangar at each base and aircraft using a military style flight line model. Costs of office space for maintenance operations are accounted for separately and included in the calculations.
15. Additional sub-contract cost such as periodic aircraft washing, painting, navigation data and weather support services are accounted for using commercial off-the-shelf average service rates.

Annual Cost Projection

Lifecycle cost projections depict only annual cost averages and cannot be used effectively to establish annual budgets due to cyclical variables such as aircraft maintenance schedules. Some costs are not encountered during certain years as they fall in the off-cycle years while some costs are encountered every year. Below are graphs depicting the lifecycle of two aircraft to help understand which years, if any, budget needs are greater than other years. The two represented aircraft in each graph are the oldest aircraft the Forest Service is expected to receive from DoD with its estimated airframe hours and the newest aircraft to be received right off the assembly line. Additionally, there are two separate charts to represent a 250 flight hour per aircraft annual rate and a comparative 400 flight hour per aircraft annual rate.

Major maintenance inspections and component overhauls are generally the reason for spikes during some years. The spikes are not always linear for the compared aircraft due to DoD's previous annual utilization rate for the first segment of the aircraft's life then changing to a lesser rate for Forest Service use. With the depiction of the oldest and newest aircraft overlapped, it is possible to see where the fleet as a whole will lie between these posts. The ebbs and flows of the yearly budget requirements can also be identified.

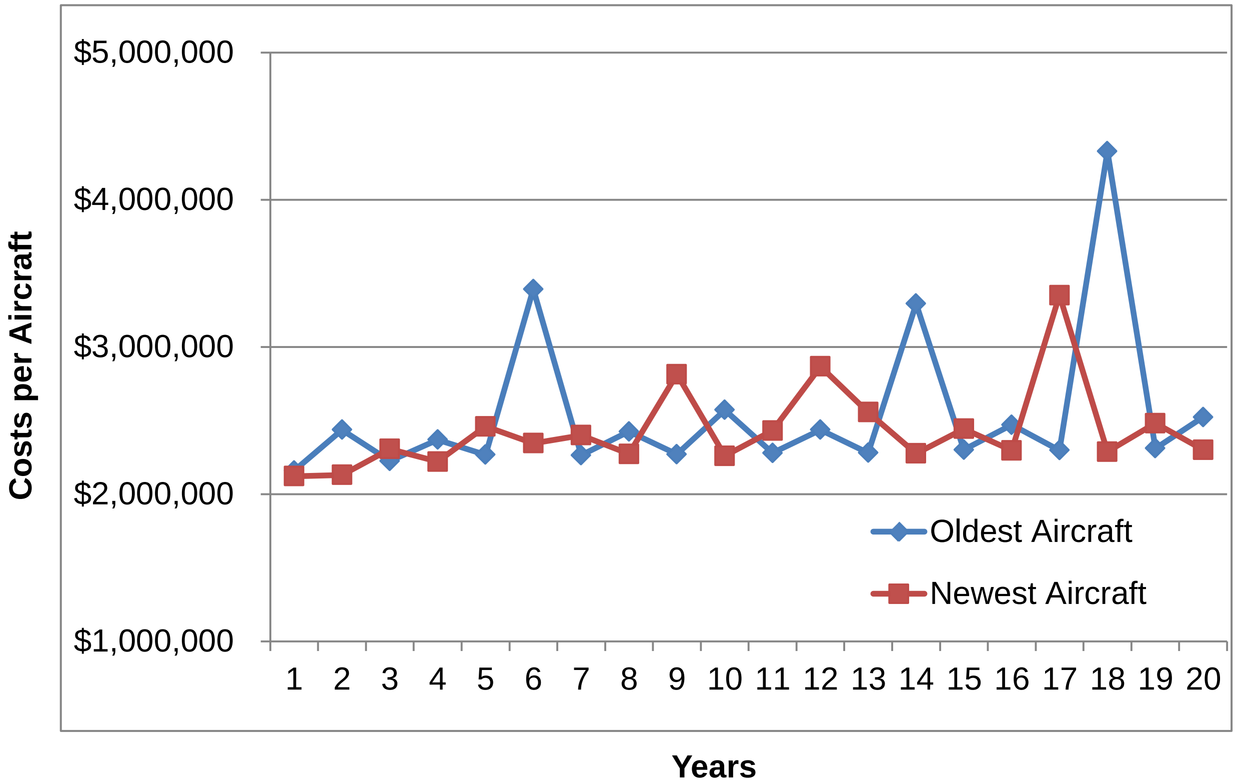


Figure 16 Annual Cost Estimate 250 Hours

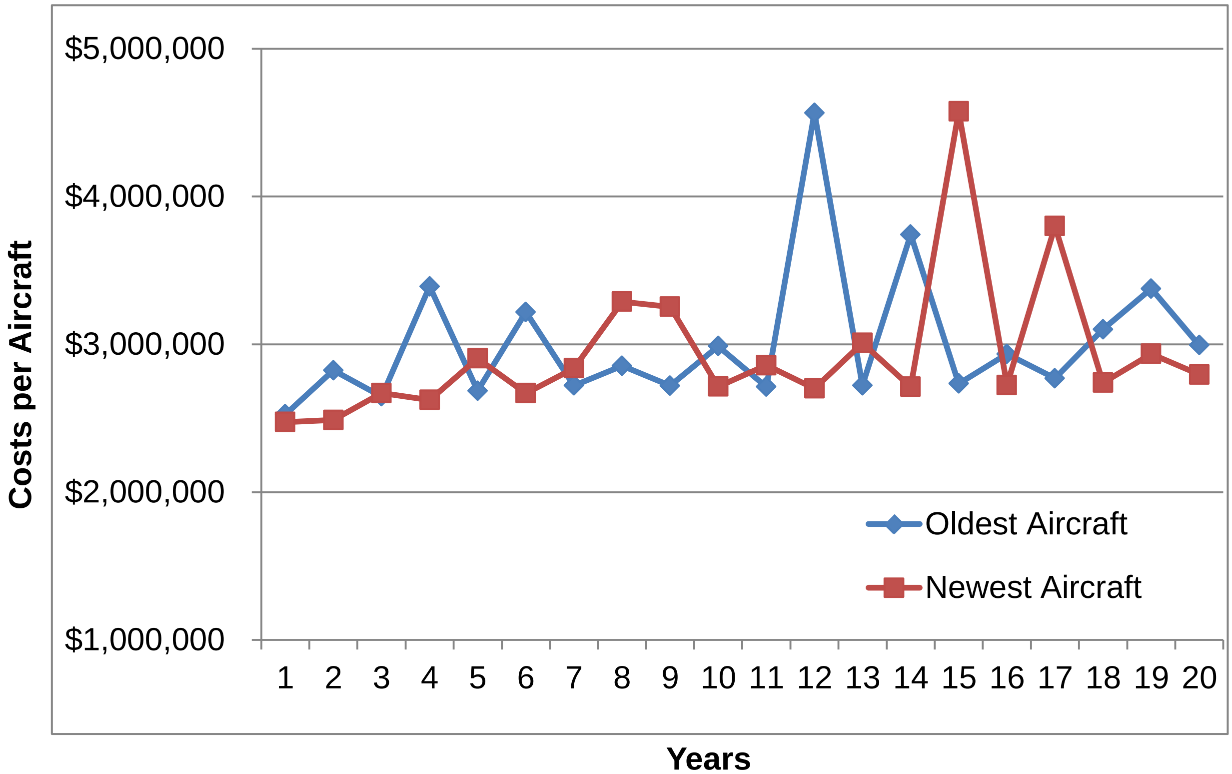


Figure 17 Annual Cost Estimate 400 Hours

Conclusion

Pros

Aircraft

The C27J is a state of the art cargo and airdrop platform that can be easily used to transport personnel. The robust avionics suite and glass cockpit with HUDs provide safety and capability beyond all aircraft currently in use by the Forest Service. The C-27J aircraft design features are ideal for parachute operations, as well as low-level air tanker operations in diverse terrain. The C-27J's triple spar wings and 3G capability to maneuver make it an ideal mid-size platform for fire retardant delivery. Its austere field capability offers avenues to increase Forest Service fire fighting capability. The C-27J has great range with virtually unlimited day/night and all-weather capability that can be used to expand the Forest Service's current operating environment and eliminate restrictions. The engine and propeller combination are industry proven as reliable and maintainable. The advantage to the Forest Service that these aircraft are "new"—maintainable and reliable—and not legacy/resuscitated aircraft cannot be under-emphasized. Additionally, operating a new aircraft historically ensures OEM parts manufacturing will not be a concern.

Training

The current aircrew training available is robust and incorporates full motion simulation combined with actual aircraft flying through all phases of training to include airdrop and night vision goggle operations for both pilots and loadmasters. When the available training syllabus is complete, aircrew are proficient at all levels of automation and equipment employment. Training is available currently at Warner- Robbins, GA, which eliminates significant travel costs to Europe for training.

Cost

The advantage of having these aircraft transferred without acquisition cost is tremendous. The relative costs to maintain a new, state of the art aircraft of this size and capability are relatively low comparative to other new aircraft of the same category. Because of the lack of an acquisition cost burden, these aircraft will likely be the least expensive C-27J aircraft to operate per lifecycle flight hour. Additionally, the benefit of not having to acquisition a replacement for 30 years is cost saving in itself.

Cons

Aircraft

The C-27J should be more capable of carrying heavier loads. The manufacturer has placed a fairly low maximum zero fuel weight on the aircraft that restricts the cargo load and will only allow an increase in cargo as fuel is added to the wings compensating for wing root binding moments. This complicated cargo/fuel calculation reduces capability since the fuel used to offset the additional cargo cannot be burned in order to remain above the limiting zero fuel weight. The Forest Service would have to engage with the manufacturer to obtain relief from this limitation in order to realize the aircraft full cargo carrying potential. This would likely involve the manufacturer providing an airworthiness certification, reduced life expectancy for the aircraft, and additional inspections and monitoring equipment at an undermined additional cost.

Additionally, the gross weight of the C-27J is low by cargo plane standard; however, this weight may be considered heavy when operating the C-27J in a “last mile forward” mission utilizing some of the existing Forest Service airfields (turf, gravel and dirt), and may create a financial burden to the Forest Service for increased airfield maintenance due to repetitive operations. The newness of the aircraft version and manufacturer safety “recalls” or “fleet groundings” as the bugs are worked out can also hinder operations. While the airframe is based on the Italian G222(C-27A) that has seen many years of service, the C-27J has undergone many improvements and modifications from its predecessor that will take some time to break-in. Additionally, the most current data from DoD deployed operations has reflected a slow parts supply line from the manufacturer to the deployed field. Maintainers have not reported the same delays while conducting stateside training. Many variable could support just as many conclusions drawn from this discrepancy in the supply chain. The main point would be a possible inconsistency in the supply chain may exist and to be prepared for this.

Training

The C-27J is training intensive and requires constant skill application by the aircrews to remain proficient and mission-ready. Although highly automated, this is not an aircraft that can be effectively and safely operated with min-run training and skill. It requires highly skilled professional aircrew. The training available is thorough and adequate, but it is time consuming (2- 3 months) and relatively expensive in its current form. The length of training and lead-time required to have a fully qualified crewmember to meet fire season operational demand will require structured, deliberate, action. Training is only offered by two sources, one being the manufacturer, but it is conducted overseas with equipment not representative of the aircraft the Forest Service would receive and is generally limited to new purchase customers as part of the point of sale agreement. The only US based training offered is in Warner-Robbins, GA.

Cost

Operations maintenance and costs could present challenges. Although “free” of acquisition cost, the overall lifecycle cost of operation may be historically more than any other aircraft the Forest Service has ever owned. The newness of the aircraft in the marketplace always places an uncertainty on true cost to operate, and while most realize more and more economies as additional users, suppliers and maintainers enter the market place, there is a risk that operating cost may increase over time. The Forest Service must also deal with the added burden of costs related to their Working Capital Fund which is not represented in this cost analysis.

Appendix A: Alturas Municipal Airport, California (KATT) Scenario

Assumptions:

Tactical takeoff procedures are used	
2 fire crews (40 passengers and light equipment (5,300 lbs × 2) =	10,600 lb
Basic Op Weight[43] =	44,100 lb
Start + taxi =	200 lb
Climb fuel[44] =	750 lb
Cruise fuel[45] =	2,200 lb
Approach + landing =	200 lb
Reserve fuel[46] =	1,100 lb
Min landing fuel =	1,500 lb
Total takeoff weight =	60,650 lb

Notes: Airfield Pavement Classification Number (PCN) information is not available for KATT. The takeoff and landing data presented in the tables for KATT assumes PCN and Aircraft Classification Number (ACN) are compatible and represent an approximate value of 26 for a Dual Tandem wheel configuration.

[43] Basic Operating Weight based on US configuration (46,200 lb) with cockpit armor and non-essential mission gear removed (2,100 lbs).
[44] Conservative value for a climb to 18,000' MSL.
[45] Conservative value for 1 hour cruise 18,000' MSL at Long Range Cruise (LRC) airspeed (~250 KTAS). Includes descent fuel.
[46] Approximately 45 min at 10,000 MSL and long range cruise (LRC).

Flaps 1 No Wind PA 4364 ft Runway 03 (0.4% gradient) 3096 x 60 ft Braking Coefficient = 0.5 (Asphalt) Gross Weight 60,650 lbs V_1/V_R = 1.0 V_{LO}/V_S = 1.14 V_{CO}/V_S= 1.15				
Temp (°C)	Climb Gradient CEI (%)	Accel Stop Dist (ft)	Ground Run CEI (ft)	Ground Run AEO (ft)
40	1.7	5510	5138	3573
35	2.1	5118	4862	3355
30	2.4	4726	4587	3137
25	2.7	4404	4343	2942
20	2.9	4224	4200	2819
15	3.1	4065	4092	2720

Table 14 Alturas Municipal (KATT) Rwy 03 Flaps 1

Flaps 2 No Wind PA 4364 ft Runway 03 (0.4% gradient) 3096 x 60 ft Braking Coefficient = 0.5 (Asphalt) Gross Weight 60,650 lbs V_1/V_R = 1.0 V_{LO}/V_S = 1.14 V_{CO}/V_S= 1.15				
Temp (°C)	Climb Gradient CEI (%)	Accel Stop Dist (ft)	Ground Run CEI (ft)	Ground Run AEO (ft)
40	< 1.0	4576	4881	2832
35	1	4315	4660	2666
30	1.4	4055	4440	5201
25	1.8	3826	4237	2351
20	2	3688	4103	2253
15	2.1	3579	3996	2174

Table 15 Alturas Municipal (KATT) Rwy 03 Flaps 2

Flaps 1 No Wind PA 4364 ft				
Runway 13 (0.2% gradient) 4,300 x 50 ft				
Braking Coefficient = 0.5 (Asphalt)				
Gross Weight 60,650 lbs				
V_1/V_R = 1.0				
V_{LO}/V_S = 1.14				
V_{CO}/V_S= 1.15				
Temp (°C)	Climb Gradient CEI (%)	Accel Stop Dist (ft)	Ground Run CEI (ft)	Ground Run AEO (ft)
40	1.7	5453	5090	3535
35	2.1	5065	4817	3320
30	2.4	4677	4544	3105
25	2.7	4359	4303	2913
20	2.9	4180	4126	2791
15	3.1	4024	4055	2694

Table 16 Alturas Municipal (KATT) Rwy 13 Flaps 1

Flaps 2 No Wind PA 4364 ft				
Runway 13 (0.2% gradient) 4,300 x 50 ft				
Braking Coefficient = 0.5 (Asphalt)				
Gross Weight 60,650 lbs				
V_1/V_R = 1.0				
V_{LO}/V_S = 1.14				
V_{CO}/V_S= 1.15				
Temp (°C)	Climb Gradient CEI (%)	Accel Stop Dist (ft)	Ground Run CEI (ft)	Ground Run AEO (ft)
40	< 1.0	4528	4831	2811
35	1	4271	4613	2647
30	1.4	4013	4395	2482
25	1.8	3786	4195	2334
20	2	3650	4062	2237
15	2.1	3542	3956	2159

Table 17 Alturas Municipal (KATT) Rwy 13 Flaps 2

Flaps 1 No Wind PA 4364 ft				
Runway 21 (-0.4% gradient) 3096 x 60 ft				
Braking Coefficient = 0.5 (Asphalt)				
Gross Weight 60,650 lbs				
$V_1/V_R = 1.0$				
$V_{LO}/V_S = 1.14$				
$V_{CO}/V_S = 1.15$				
Temp (°C)	Climb Gradient CEI (%)	Accel Stop Dist (ft)	Ground Run CEI (ft)	Ground Run AEO (ft)
40	1.7	5290	4954	3426
35	2.1	4914	4690	3219
30	2.4	4537	4425	3012
25	2.7	4229	4191	2827
20	2.9	4056	4055	2710
15	3.1	3904	3951	2617

Table 18 Alturas Municipal (KATT) Rwy 21 Flaps 1

Flaps 2 No Wind PA 4364 ft				
Runway 21 (-0.4% gradient) 3096 x 60 ft				
Braking Coefficient = 0.5 (Asphalt)				
Gross Weight 60,650 lbs				
$V_1/V_R = 1.0$				
$V_{LO}/V_S = 1.14$				
$V_{CO}/V_S = 1.15$				
Temp (°C)	Climb Gradient CEI (%)	Accel Stop Dist (ft)	Ground Run CEI (ft)	Ground Run AEO (ft)
40	< 1.0	4393	4685	2748
35	1	4143	4474	2589
30	1.4	3893	4263	2429
25	1.8	3674	4069	2284
20	2	3542	3940	2190
15	2.1	3437	3838	2113

Table 19 Alturas Municipal (KATT) Rwy 21 Flaps 2

Flaps 1 No Wind PA 4364 ft Runway 31 (-0.2% gradient) 4,300 x 50 ft Braking Coefficient = 0.5 (Asphalt) Gross Weight 60,650 lbs V_1/V_R = 1.0 V_{LO}/V_S = 1.14 V_{CO}/V_S= 1.15				
Temp (°C)	Climb Gradient CEI (%)	Accel Stop Dist (ft)	Ground Run CEI (ft)	Ground Run AEO (ft)
40	1.7	5453	4998	3461
35	2.1	4963	4731	3252
30	2.4	4583	4464	3042
25	2.7	4271	4227	2875
20	2.9	4096	4089	2737
15	3.1	3943	3985	2642

Table 20 Alturas Municipal (KATT) Rwy 31 Flaps 1

Flaps 2 No Wind PA 4364 ft Runway 31 (-0.2% gradient) 4,300 x 50 ft Braking Coefficient = 0.5 (Asphalt) Gross Weight 60,650 lbs V_1/V_R = 1.0 V_{LO}/V_S = 1.14 V_{CO}/V_S= 1.15				
Temp (°C)	Climb Gradient CEI (%)	Accel Stop Dist (ft)	Ground Run CEI (ft)	Ground Run AEO (ft)
40	< 1.0	4528	4831	2811
35	1	4271	4613	2647
30	1.4	4013	4395	2482
25	1.8	3786	4195	2334
20	2	3650	4062	2237
15	2.1	3542	3956	2159

Table 21 Alturas Municipal (KATT) Rwy 31 Flaps 2

Appendix B: Reserve Airport, New Mexico (T16) Scenarios

Scenario 1 (T16)

Assumptions:

Tactical takeoff procedures are used	
2 fire crews (40 passengers and light equipment (5,300 lbs × 2) =	10,600 lb
Basic Op Weight[47] =	44,100 lb
Start + taxi =	200 lb
Climb fuel[48] =	750 lb
Cruise fuel[49] =	2,200 lb
Approach + landing =	200 lb
Reserve fuel[50] =	1,100 lb
Min landing fuel =	1,500 lb
Total takeoff weight =	60,650 lb

Notes: Airfield PCN information not available.

[47] Basic Operating Weight based on US configuration (46,200 lb) with cockpit armor and non-essential mission gear removed (2,100 lbs).
[48] Conservative value for a climb to 18,000' MSL.
[49] Conservative value for 1 hour cruise 18,000' MSL at Long Range Cruise (LRC) airspeed (~250 KTAS). Includes descent fuel.
[50] Approximately 45 min at 10,000 MSL and long range cruise (LRC).

Flaps 1 No Wind PA 6360 ft Runway 06 (-2% gradient) 4777 x 50 ft Braking Coefficient = 0.5 (Dry Asphalt) Gross Weight 60,650 lbs V_1/V_R = 1.0 V_{LO}/V_S = 1.14 V_{CO}/V_S= 1.15				
Temp (°C)	Climb Gradient CEI (%)	Accel Stop Dist (ft)	Ground Run CEI (ft)	Ground Run AEO (ft)
38	No calculation for given conditions			
37	1.2	5682	5284	3633
35	1.3	5545	5162	3542
30	1.7	5204	4856	3323
25	2	4862	4550	3103
20	2.4	4517	4320	2918
15	2.7	4176	4139	2760

Table 22 Reserve Airport (T16) Rwy 06 Flaps 1

Flaps 2 No Wind PA 6360 ft Runway 06 (-2% gradient) 4777 x 50 ft Braking Coefficient = 0.5 (Dry Asphalt) Gross Weight 60,650 lbs V_1/V_R = 1.0 V_{LO}/V_S = 1.14 V_{CO}/V_S= 1.15				
Temp (°C)	Climb Gradient CEI (%)	Accel Stop Dist (ft)	Ground Run CEI (ft)	Ground Run AEO (ft)
38	No calculation for given conditions			
37	< 1.0	4824	4793	2971
35	< 1.0	4697	4706	2903
30	< 1.0	4397	4490	2732
25	1	4062	4274	2562
20	1.4	3823	4089	2417
15	1.7	3645	3932	2292

Table 23 Reserve Airport (T16) Rwy 06 Flaps 2

Flaps 1 No Wind PA 6360 ft

Runway 24 (2% gradient) 4777 x 50 ft

Braking Coefficient = 0.5 (Dry Asphalt)

Gross Weight 60,650 lbs

V_1/V_R = 1.0

V_{LO}/V_S = 1.14

V_{CO}/V_S= 1.15

Temp (°C)	Climb Gradient CEI (%)	Accel Stop Dist (ft)	Ground Run CEI (ft)	Ground Run AEO (ft)
38	No calculation for given conditions			
37	1.2	6958	6342	4499
35	1.3	6791	6192	4386
30	1.7	6371	5817	4105
25	2	5951	5442	3842
20	2.4	5528	5160	3588
15	2.7	5109	4939	3386

Table 24 Reserve Airport (T16) Rwy 24 Flaps 1

Flaps 2 No Wind PA 6360 ft

Runway 24 (2% gradient) 4777 x 50 ft

Braking Coefficient = 0.5 (Dry Asphalt)

Gross Weight 60,650 lbs

V_1/V_R = 1.0

V_{LO}/V_S = 1.14

V_{CO}/V_S= 1.15

Temp (°C)	Climb Gradient CEI (%)	Accel Stop Dist (ft)	Ground Run CEI (ft)	Ground Run AEO (ft)
38	No calculation for given conditions			
37	< 1.0	5904	5888	3462
35	< 1.0	5749	5780	3381
30	< 1.0	5359	5512	3178
25	1	4669	5243	2975
20	1.4	4676	5013	2802
15	1.7	4458	4808	2645

Table 25 Reserve Airport (T16) Rwy 24 Flaps 2

Scenario 2 (T16)

Assumptions:

Tactical takeoff procedures are used	
1 fire crew (20 passengers and light equipment (5,300 lbs × 2) =	5,300 lb
Basic Op Weight[51] =	44,100 lb
Start + taxi =	200 lb
Climb fuel[52] =	750 lb
Cruise fuel[53] =	2,200 lb
Approach + landing =	200 lb
Reserve fuel[54] =	1,100 lb
Min landing fuel =	1,500 lb
Total takeoff weight =	55,350 lb

Notes: Takeoff with two entire firefighting teams (40 passengers and light equipment totaling 5,300 lbs) is unlikely. The scenario presented is for 5,300 or a single firefighting team. Airfield PCN information is not available.

[51] Basic Operating Weight based on US configuration (46,200 lb) with cockpit armor and non-essential mission gear removed (2,100 lbs).
[52] Conservative value for a climb to 18,000' MSL.
[53] Conservative value for 1 hour cruise 18,000' MSL at Long Range Cruise (LRC) airspeed (~250 KTAS). Includes descent fuel.
[54] Approximately 45 min at 10,000 MSL and long range cruise (LRC).

Flaps 1 No Wind PA 6360 ft				
Runway 06 (-2% gradient) 4777 x 50 ft				
Braking Coefficient = 0.5 (Dry Asphalt)				
Gross Weight 56,650 lbs				
V_1/V_R = 1.0				
V_{LO}/V_S = 1.14				
V_{CO}/V_S= 1.15				
Temp (°C)	Climb Gradient CEI (%)	Accel Stop Dist (ft)	Ground Run CEI (ft)	Ground Run AEO (ft)
38	No calculation for given conditions			
37	1.8	4940	4683	3085
35	2	4823	4576	3011
30	2.3	4529	4308	2825
25	2.7	4235	4041	2641
20	3.1	3939	3839	2490
15	3.4	3645	3681	2362

Table 26 Reserve Airport (T16) Alternate Scenario Rwy 06 Flaps 1

Flaps 2 No Wind PA 6360 ft				
Runway 06 (-2% gradient) 4777 x 50 ft				
Braking Coefficient = 0.5 (Dry Asphalt)				
Gross Weight 56,650 lbs				
V_1/V_R = 1.0				
V_{LO}/V_S = 1.14				
V_{CO}/V_S= 1.15				
Temp (°C)	Climb Gradient CEI (%)	Accel Stop Dist (ft)	Ground Run CEI (ft)	Ground Run AEO (ft)
38	No calculation for given conditions			
37	< 1.0	4204	4253	2534
35	< 1.0	4094	4176	2476
30	1.3	4154	4377	2495
25	1.8	3856	4165	2338
20	2.1	3631	3984	2204
15	2.5	3464	3822	2089

Table 27 Reserve Airport (T16) Alternate Scenario Rwy 06 Flaps 2

Flaps 1 No Wind PA 6360 ft Runway 24 (2% gradient) 4777 x 50 ft Braking Coefficient = 0.5 (Dry Asphalt) Gross Weight 56,650 lbs $V_1/V_R = 1.0$ $V_{LO}/V_S = 1.14$ $V_{CO}/V_S = 1.15$				
Temp (°C)	Climb Gradient CEI (%)	Accel Stop Dist (ft)	Ground Run CEI (ft)	Ground Run AEO (ft)
38	No calculation for given conditions			
37	1.8	6048	5605	3802
35	2	5903	5474	3706
30	2.3	5543	5146	3469
25	2.7	5182	4818	3231
20	3.1	4818	4571	3031
15	3.4	4457	4377	2861

Table 28 Reserve Airport (T16) Alternate Scenario Rwy 24 Flaps 1

Flaps 2 No Wind PA 6360 ft Runway 24 (2% gradient) 4777 x 50 ft Braking Coefficient = 0.5 (Dry Asphalt) Gross Weight 56,650 lbs $V_1/V_R = 1.0$ $V_{LO}/V_S = 1.14$ $V_{CO}/V_S = 1.15$				
Temp (°C)	Climb Gradient CEI (%)	Accel Stop Dist (ft)	Ground Run CEI (ft)	Ground Run AEO (ft)
38	No calculation for given conditions			
37	< 1.0	5144	5217	2942
35	< 1.0	5009	5122	2873
30	1.3	4672	4884	2701
25	1.8	4335	4647	2529
20	2.1	4081	4443	2383
15	2.5	3892	4246	2257

Table 29 Reserve Airport (T16) Alternate Scenario Rwy 24 Flaps 2

Appendix C: Negrito Airstrip, New Mexico (0NM7) Scenario

Assumptions:

Tactical takeoff procedures are used	
2 fire crews (40 passengers and light equipment (5,300 lbs × 2) =	10,600 lb
Basic Op Weight[55] =	44,100 lb
Start + taxi =	200 lb
Climb fuel[56] =	750 lb
Cruise fuel[57] =	2,200 lb
Approach + landing =	200 lb
Reserve fuel[58] =	1,100 lb
Min landing fuel =	1,500 lb
Total takeoff weight =	60,650 lb

Notes: Airfield CBR or weight bearing capacity not available. Although these ratings are not available, turf/gravel generally supports the C-27J and it is assumed this is the case for Negrito Airstrip.

[55] Basic Operating Weight based on US configuration (46,200 lb) with cockpit armor and non-essential mission gear removed (2,100 lbs).
[56] Conservative value for a climb to 18,000' MSL.
[57] Conservative value for 1 hour cruise 18,000' MSL at Long Range Cruise (LRC) airspeed (~250 KTAS). Includes descent fuel.
[58] Approximately 45 min at 10,000 MSL and long range cruise (LRC).

Flaps 1 No wind PA 8143 ft

Runway 03 4000 x 60 ft

Braking Coefficient = 0.39 (Dirt)

Gross Weight 60,650 lbs

$V_1/V_R = 1.0$

$V_{LO}/V_S = 1.14$

$V_{CO}/V_S = 1.15$

Temp (°C)	Climb Gradient CEI (%)	Accel Stop Dist (ft)	Ground Run CEI (ft)	Ground Run AEO (ft)
25	1.4	6441	5683	4051
20	1.8	6038	5350	3779
15	2.1	5667	5055	3555

Table 30 Negrito Airstrip (0NM7) Rwy 03 Flaps 1

Flaps 2 No wind PA 8143 ft

Runway 03 4000 x 60 ft

Braking Coefficient = 0.39 (Dirt)

Gross Weight 60,650 lbs

$V_1/V_R = 1.0$

$V_{LO}/V_S = 1.14$

$V_{CO}/V_S = 1.15$

Temp (°C)	Climb Gradient CEI (%)	Accel Stop Dist (ft)	Ground Run CEI (ft)	Ground Run AEO (ft)
34	No calculation for given conditions			
33	< 1.0	6283	5726	3587
30	< 1.0	6032	5582	3451
25	< 1.0	5614	5342	3239
20	< 1.0	5211	5108	3032
15	1.1	4903	4887	2860

Table 31 Negrito Airstrip (0NM7) Rwy 03 Flaps 2

Flaps 1 No Wind PA 8143 ft Runway 17 7,500 x 60 ft Braking Coefficient = 0.39 (Dirt) Gross Weight 60,650 lbs V_1/V_R = 1.0 V_{LO}/V_S = 1.14 V_{CO}/V_S= 1.15				
Temp (°C)	Climb Gradient CEI (%)	Accel Stop Dist (ft)	Ground Run CEI (ft)	Ground Run AEO (ft)
34	No calculation for given conditions			
33	< 1.0	7086	6237	4495
30	1.1	6848	6029	4329
25	1.4	6441	5683	4051
20	1.8	6038	5350	3779
15	2.1	5667	5055	3555

Table 32 Negrito Airstrip (0NM7) Rwy 17 Flaps 1

Flaps 2 No Wind PA 8143 ft Runway 17 7,500 x 60 ft Braking Coefficient = 0.39 (Dirt) Gross Weight 60,650 lbs V_1/V_R = 1.0 V_{LO}/V_S = 1.14 V_{CO}/V_S= 1.15				
Temp (°C)	Climb Gradient CEI (%)	Accel Stop Dist (ft)	Ground Run CEI (ft)	Ground Run AEO (ft)
34	No calculation for given conditions			
33	< 1.0	6283	5726	3587
30	< 1.0	6032	5582	3451
25	< 1.0	5614	5342	3239
20	< 1.0	5211	5108	3032
15	1.1	4903	4887	2860

Table 33 Negrito Airstrip (0NM7) Rwy 17 Flaps 2

Flaps 1 No Wind PA 8143 ft Runway 21 4000 x 60 ft Braking Coefficient = 0.39 (Dirt) Gross Weight 60,650 lbs V_1/V_R = 1.0 V_{LO}/V_S = 1.14 V_{CO}/V_S= 1.15				
Temp (°C)	Climb Gradient CEI (%)	Accel Stop Dist (ft)	Ground Run CEI (ft)	Ground Run AEO (ft)
25	1.4	6441	5683	4051
20	1.8	6038	5350	3779
15	2.1	5667	5055	3555

Table 34 Negrito Airstrip (0NM7) Rwy 21 Flaps 1

Flaps 2 No Wind PA 8143 ft Runway 21 4000 x 60 ft Braking Coefficient = 0.39 (Dirt) Gross Weight 60,650 lbs V_1/V_R = 1.0 V_{LO}/V_S = 1.14 V_{CO}/V_S= 1.15				
Temp (°C)	Climb Gradient CEI (%)	Accel Stop Dist (ft)	Ground Run CEI (ft)	Ground Run AEO (ft)
34	No calculation for given conditions			
33	< 1.0	6283	5726	3587
30	< 1.0	6032	5582	3451
25	< 1.0	5614	5342	3239
20	< 1.0	5211	5108	3032
15	1.1	4903	4887	2860

Table 35 Negrito Airstrip (0NM7) Rwy 21 Flaps 2

Flaps 1 No Wind PA 8143 ft				
Runway 35 7,500 x 60 ft				
Braking Coefficient = 0.39 (Dirt)				
Gross Weight 60,650 lbs				
V_1/V_R = 1.0				
V_{LO}/V_S = 1.14				
V_{CO}/V_S= 1.15				
Temp (°C)	Climb Gradient CEI (%)	Accel Stop Dist (ft)	Ground Run CEI (ft)	Ground Run AEO (ft)
34	No calculation for given conditions			
33	< 1.0	7086	6237	4495
30	1.1	6848	6029	4329
25	1.4	6441	5683	4051
20	1.8	6038	5350	3779
15	2.1	5667	5055	3555

Table 36 Negrito Airstrip (0NM7) Rwy 25 Flaps 1

Flaps 2 No Wind PA 8143 ft				
Runway 35 7,500 x 60 ft				
Braking Coefficient = 0.39 (Dirt)				
Gross Weight 60,650 lbs				
V_1/V_R = 1.0				
V_{LO}/V_S = 1.14				
V_{CO}/V_S= 1.15				
Temp (°C)	Climb Gradient CEI (%)	Accel Stop Dist (ft)	Ground Run CEI (ft)	Ground Run AEO (ft)
34	No calculation for given conditions			
33	< 1.0	6283	5726	3587
30	< 1.0	6032	5582	3451
25	< 1.0	5614	5342	3239
20	< 1.0	5211	5108	3032
15	1.1	4903	4887	2860

Table 37 Negrito Airstrip (0NM7) Rwy 25 Flaps 2

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