NASA
Subsonic Rotary Wing Project

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Rotorcraft in the Next Gen Airspace

- Demonstrate analytically that rotorcraft can be successfully integrated into Next Gen airspace
- Identify unique Next Gen technologies and concepts of operations that might be required to maximize safe, efficient, environmental responsive, and economic employment of rotorcraft in the Next Gen airspace
- Demonstrate with modern, accepted analysis/simulation tools that rotorcraft can be a potential solution to airport/airspace congestion
- Provide insights into rotorcraft-specific technology advances that will be required

What is “Next Gen?”

“NextGen is a wide ranging **transformation of the entire national air transportation system** — not just certain pieces of it — to meet future demands and avoid gridlock in the sky and at the airports. It moves away from ground-based surveillance and navigation to new and more dynamic **satellite-based systems and procedures**, and introduces new technological **innovations in** areas such as **weather forecast, digital communications and networking**. When fully implemented, NextGen will safely **allow more aircraft to fly more closely together on more direct routes**, reducing delays, and providing unprecedented benefits for the environment and the economy through reductions in carbon emissions, fuel consumption, and noise.”

http://www.faa.gov/about/initiatives/nextgen/

What will happen if Next Gen is not implemented?

"Without NextGen there will be **gridlock in the skies**. **By 2022**, FAA estimates that this failure would **cost the U.S. economy $22 billion annually** in lost economic activity. That number grows to more than **$40 billion by 2033** if the air transportation system is not transformed. Even as early as 2015 FAA simulation shows that without some of the initial elements of NextGen aviation **delays will be far greater than those today**."

Making Sure Rotorcraft Requirements are Factored into Next Gen Tech & CONOPS

- Primary emphasis of Next Gen implementation is, not unexpectedly, on subsonic fixed-wing jet aircraft
- It is vitally important to ensure that rotorcraft requirements are adequately factored into Next Gen technologies and concepts of operation
- Without proper attention to rotorcraft-specific technology and operational questions and issues the full potentiality of future rotorcraft systems might not be realized

NASA Airspace Systems' NRA Effort

- Ongoing Airspace Systems-sponsored "Advanced Vehicles in Next Gen Airspace" study; in the final few months of an 18-month study effort by two contractor teams

- NASA SRW provided Sensis-led NRA team 90-PAX LCTR2 reference design for airspace modeling effort‡

- But consensus within SRW is that NRA Effort needed to be expanded upon -- that led to the initiation of SRW-sponsored "Civil Tiltrotor (CTR) in Next Gen" study

‡Acree, C.W., Yeo, H., and Sinsay, J.D., "Performance Optimization of the NASA Large Civil Tiltrotor," AIAA/AHS/SAE International Powered Lift Conference, July 2008.

“CTR in Next Gen” Study Tasks

- Task 1 -- Identify attributes of a CTR fleet
  - AvDemand demand modeling and baseline fleet size definition for 2025 time frame
  - PRESTO conceptual design/sizing effort for CTR vehicles
  - BADA flight profile performance modeling for input to ACES airspace simulations
- Task 2 -- Develop procedures for CTR operations
- Task 3 -- Establish performance metrics for airspace simulations
- Task 4 -- Identify/modify/develop required analytical tools for airspace simulations
- Task 5 -- Assess system-level effects of CTR procedures/operations in Next Gen (through ACES airspace simulations)
- Task 6 -- Define safety considerations and mitigation strategies
- Task 7 -- Assess CTR fleet response in a major US urban area disaster relief effort
- Task 8 -- Identify areas for future NASA research

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Not One, but a Family of Vehicles Being Studied

- CTR airspace simulations will be based on a fleet of 10-, 30-, 90-, and 120-PAX vehicles
- 10- and 30-PAX vehicle design heritage based, in part, on BA-609 and V-22
- 90- and 120-PAX vehicles will be clean-sheet conceptual designs based on Bell Helicopter technology projections for IOP's of 2020.
- Additionally, both VTOL and STOL takeoff and landing profiles will be incorporated in pilot-in-the-loop and airspace simulations
- Bell PRESTO sizing analysis used for vehicles

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Progress to Date

- Nine months into Year 1 effort
- Design requirements for family of CTR vehicles agreed to by team
- Conceptual designs completed for 10-, 30-, and 120-PAX vehicles
- Demand modeling and informal team assessments established a baseline fleet size for vehicles for 2025 time frame
- Given design data, BADA models are currently being developed; the 10-PAX vehicle is first to be modeled
- BADA models will be used as initial input for ACES airspace simulations
- Pilot-in-the-loop simulation test plan for terminal area operation assessments is currently being finalized

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General Conceptual Design Requirements

Number of Pax	10	30	90	120
Takeoff Condition	5k/Hot	-->	-->	-->
Takeoff Procedure (1)	VTOL	VTOL	VTOL	VTOL
Takeoff Configuration	Helo	Helo	Helo	Helo
Payload, lbs	2200	6600	19800	26400
Design Range, nm	800 (2)	1000 (2)	1000	1200
Cruise Altitude, 1000 ft	25	25	30 (2)	27.5
Cruise Speed, ktas	Fallout	Fallout	300 (2)	345

(1) VTOL is assumed to be a Cat A procedure and is a target for 10 and 30-pax designs
(2) Target

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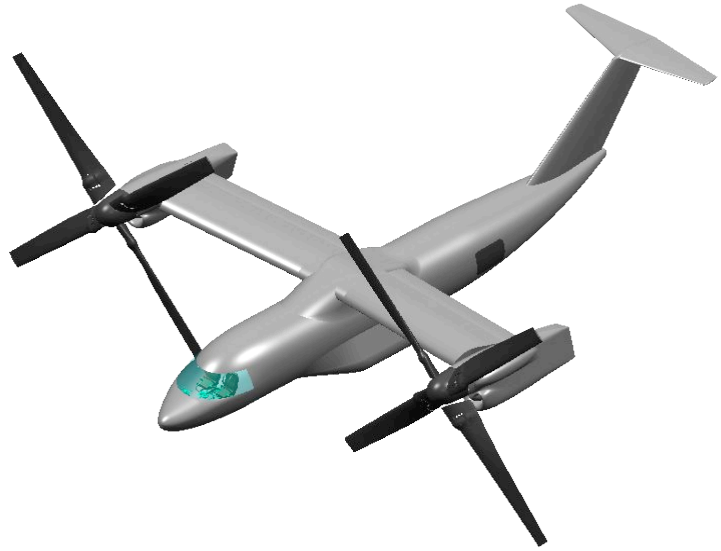
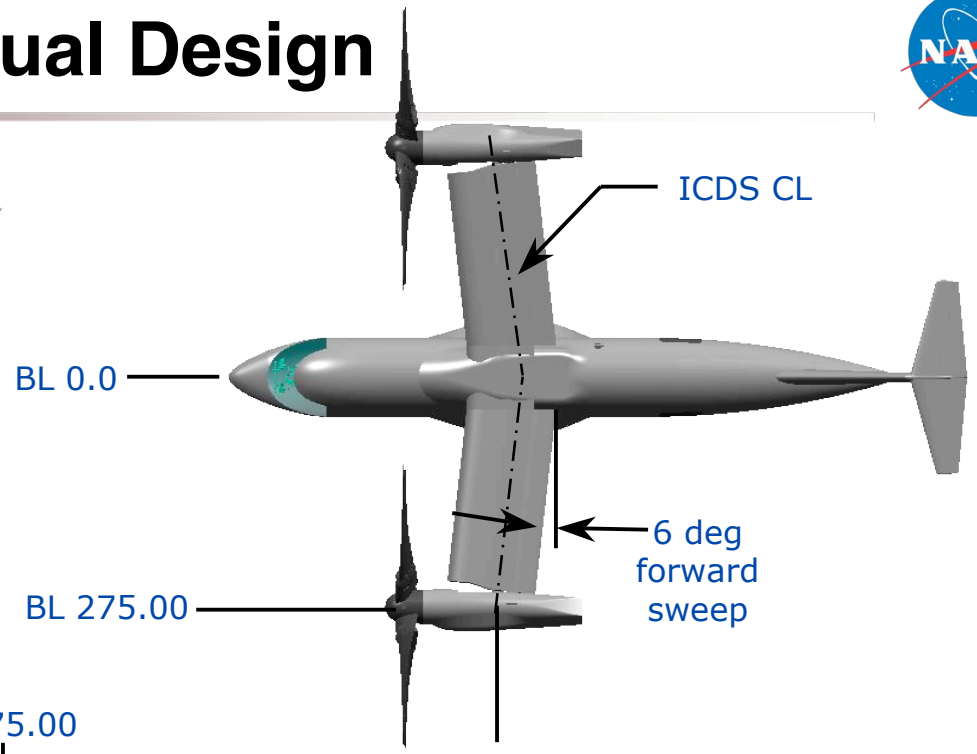
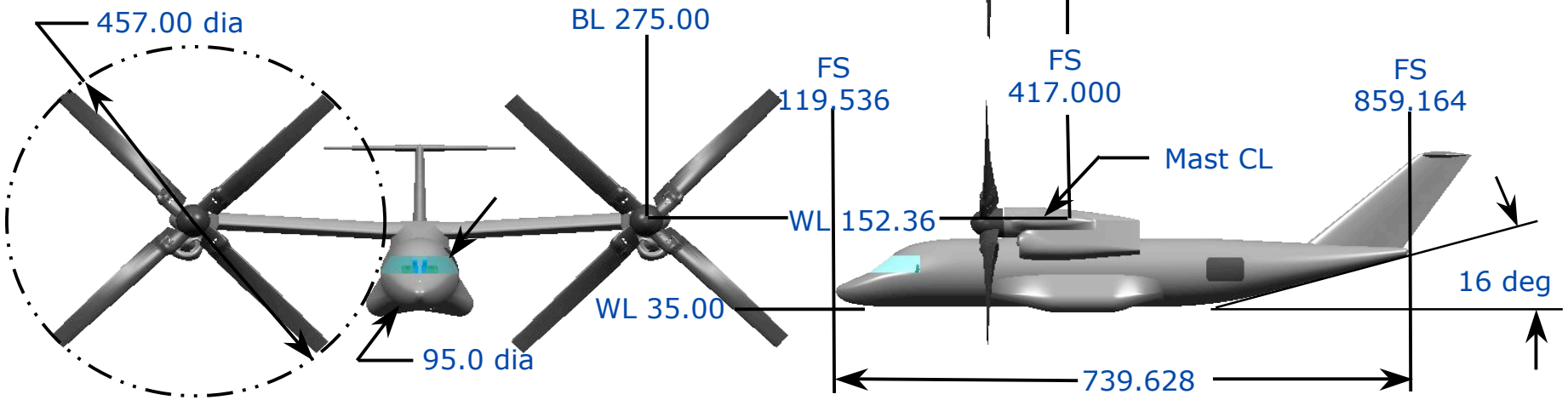
30-Pax CTR Conceptual Design







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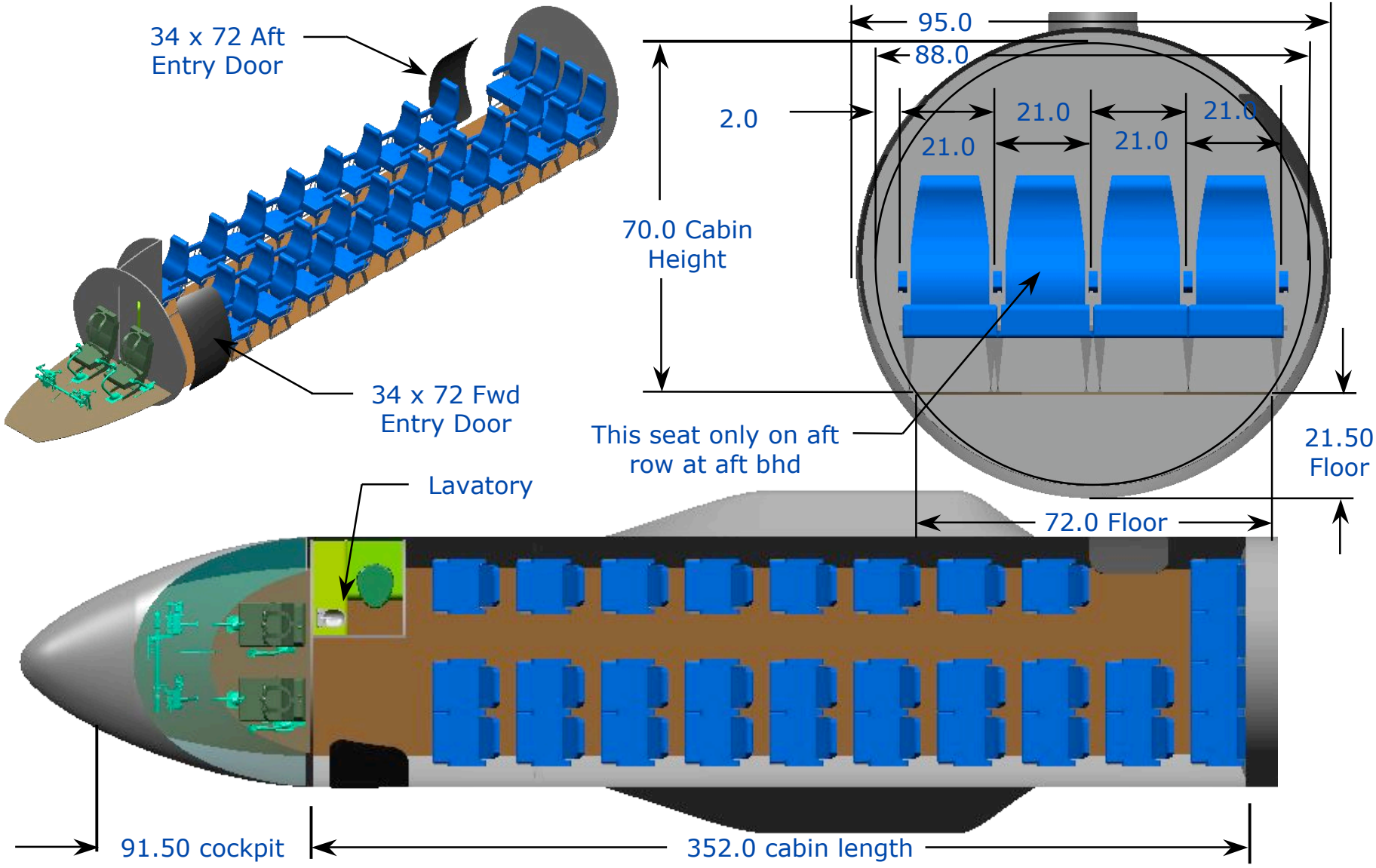
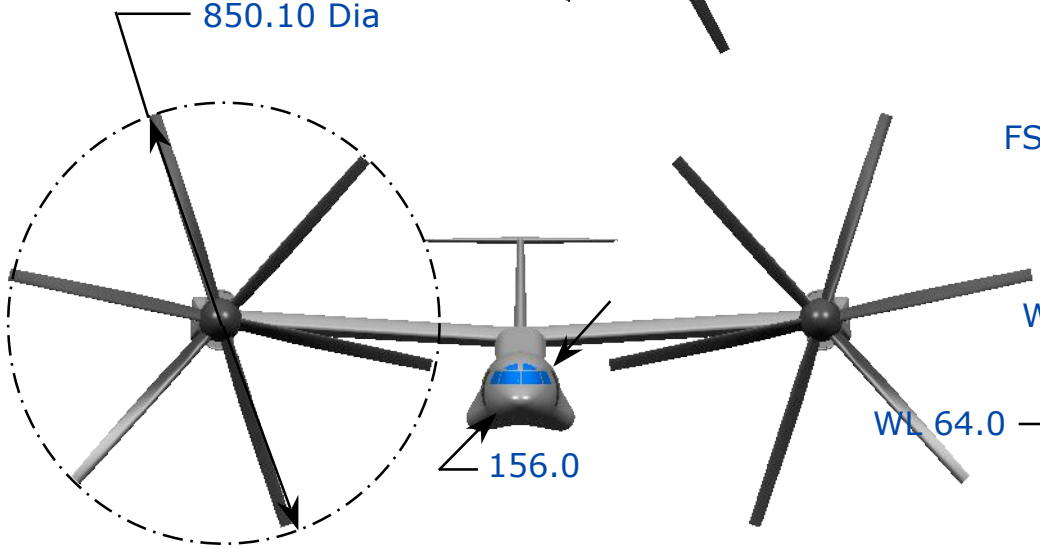
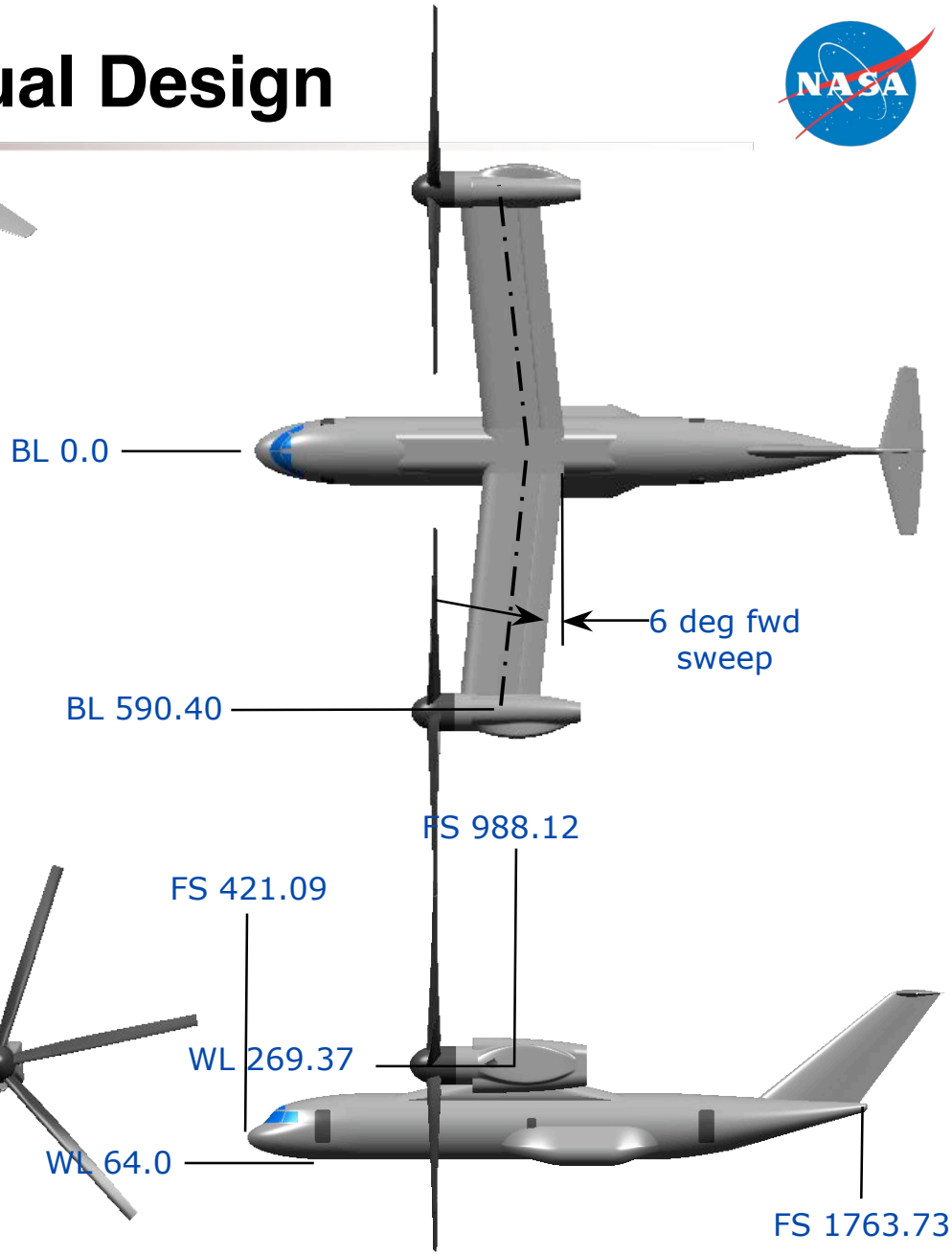
30-Pax CTR Cont.

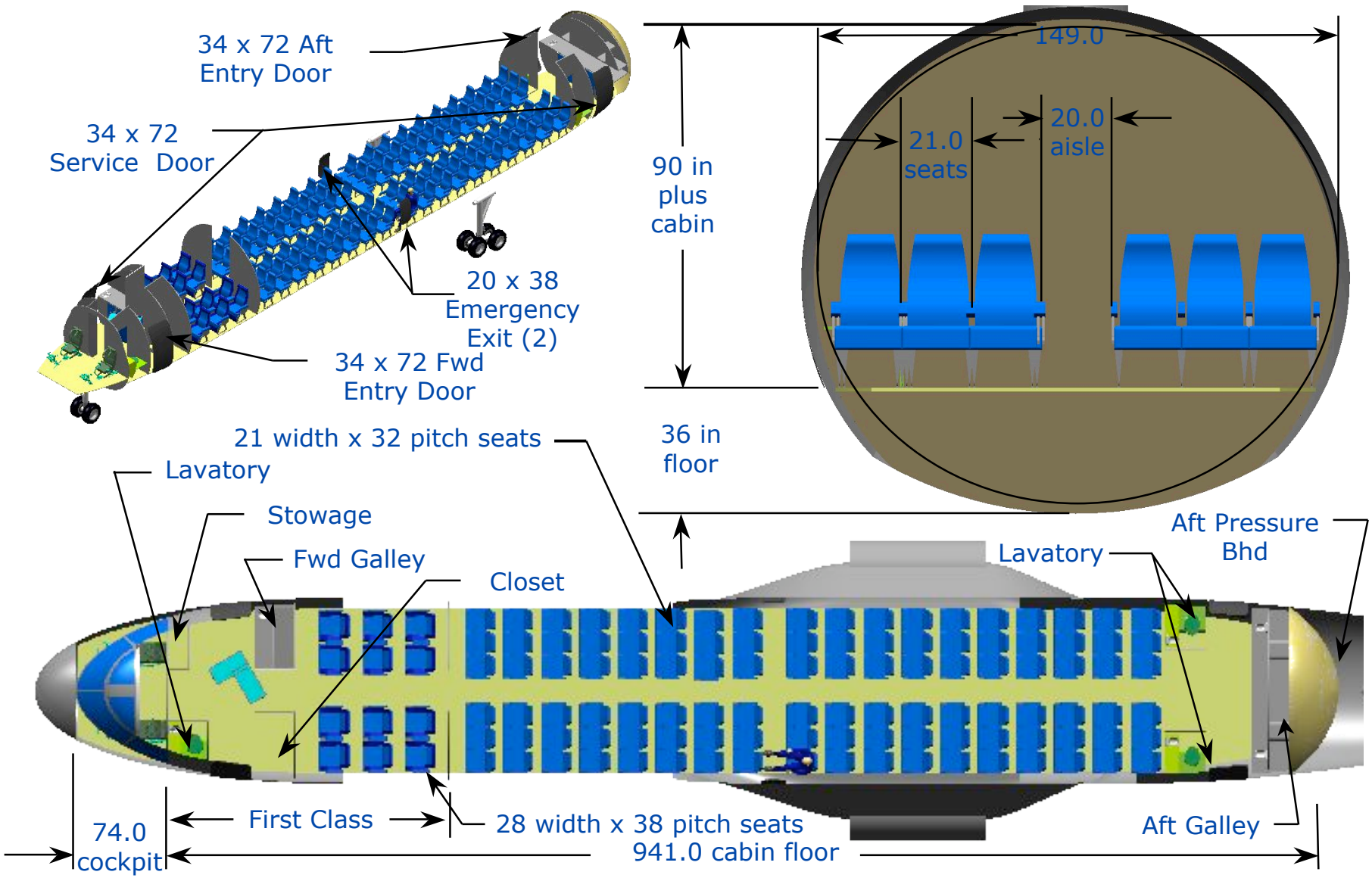


120-PAX CTR Conceptual Design



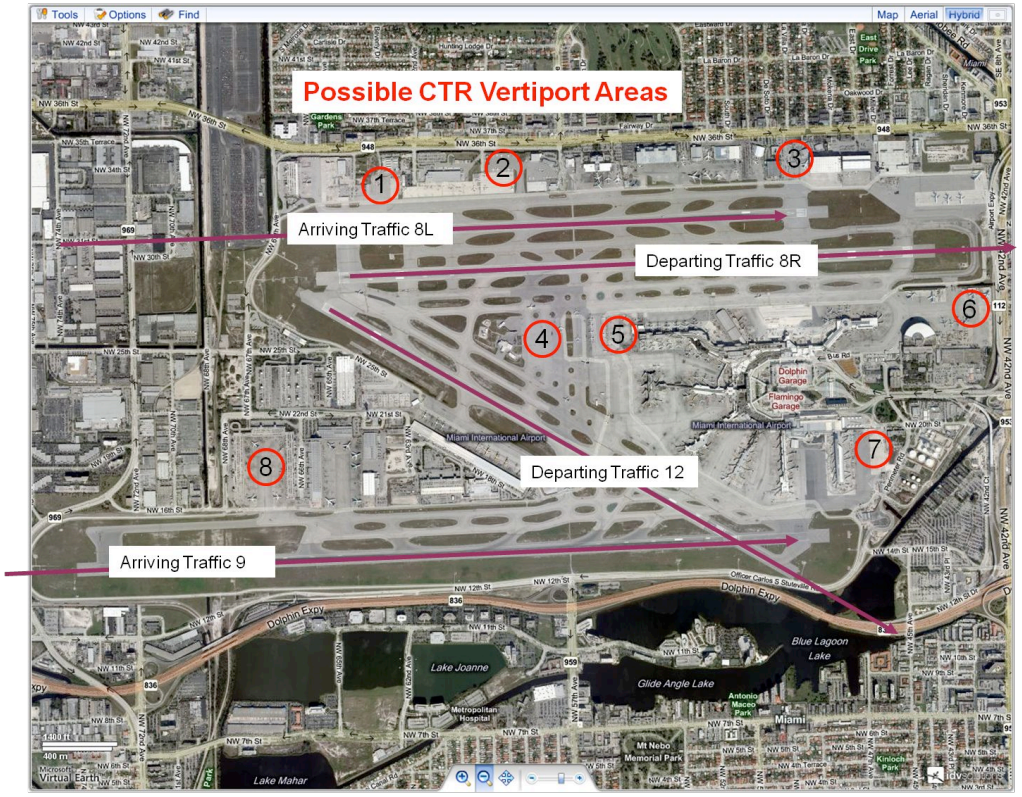


120-Pax CTR Cont.



Future Plans -- Pilot-in-the-Loop Simulations

- Pilot-in-the-loop simulations will be performed at Bell Helicopter in next few weeks
- Because of simulator logistic reasons, terminal area simulations will be at Miami airport (MIA)
- ACES airspace simulations, though, will focus on New York Metroplex
- Intent of pilot-in-the-loop simulations is to test generally applicable terminal area CONOPS that are applicable for later ACES simulation
- Additionally, Bell simulator data will be used to help validate BADA/ACES models



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Future Plans -- ACES Simulations

- During Year 2 effort, CTR BADA models will be transformed to ACES models
- ACES is a well-known NASA-developed airspace simulation tool
- Airspace simulations will be used to assess impact of CTR fleet to increase capacity/throughput of congested airports in 2025 time frame
- Study primary focus will be on New York Metroplex (same as Airspace Systems Program's NRA efforts)
- CTR fleet size for 2025 was based in part on demand modeling and informal team assessments

	TR10	TR30	TR90	TR120
Aircrafts in need	351	1303	369	343
Aircrafts available	200	150	100	50
Aircraft used in generated demandset	**199**	**168**	**130**	**55**

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Future Plans -- CTR Public Service/Disaster Relief Modeling

- Public service missions are a singular and key aspect of rotorcraft; CTR will be no different
- During Year 3 effort, specialized simulation tools will be used to assess utility of CTR fleet for disaster relief missions
- Prototypical scenario to consider is a hurricane relief effort
- One possibility to consider in analysis is a CRAF-like (Civil Reserve Air Fleet) CTR civilian fleet response to disaster scenario

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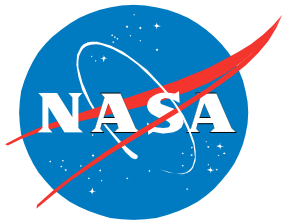
Concluding Remarks

- A challenging but valuable exercise so far
- SRW-sponsored “CTR in Next Gen Airspace” study significantly leverages off Airspace Systems Program “Advanced Vehicles in Next Gen” NRA Studies
- Already gaining considerable insights from CTR conceptual design efforts
- Next few months will see pilot-in-the-loop simulations completed and the beginning of ACES airspace simulation



Questions?