OBOGS Chemical Challenge Test Stand: New DOD Test Capability Announcement

20-22 August 2024

Presented to:
2024 OSCG Annual Meeting

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DISCLAIMERS

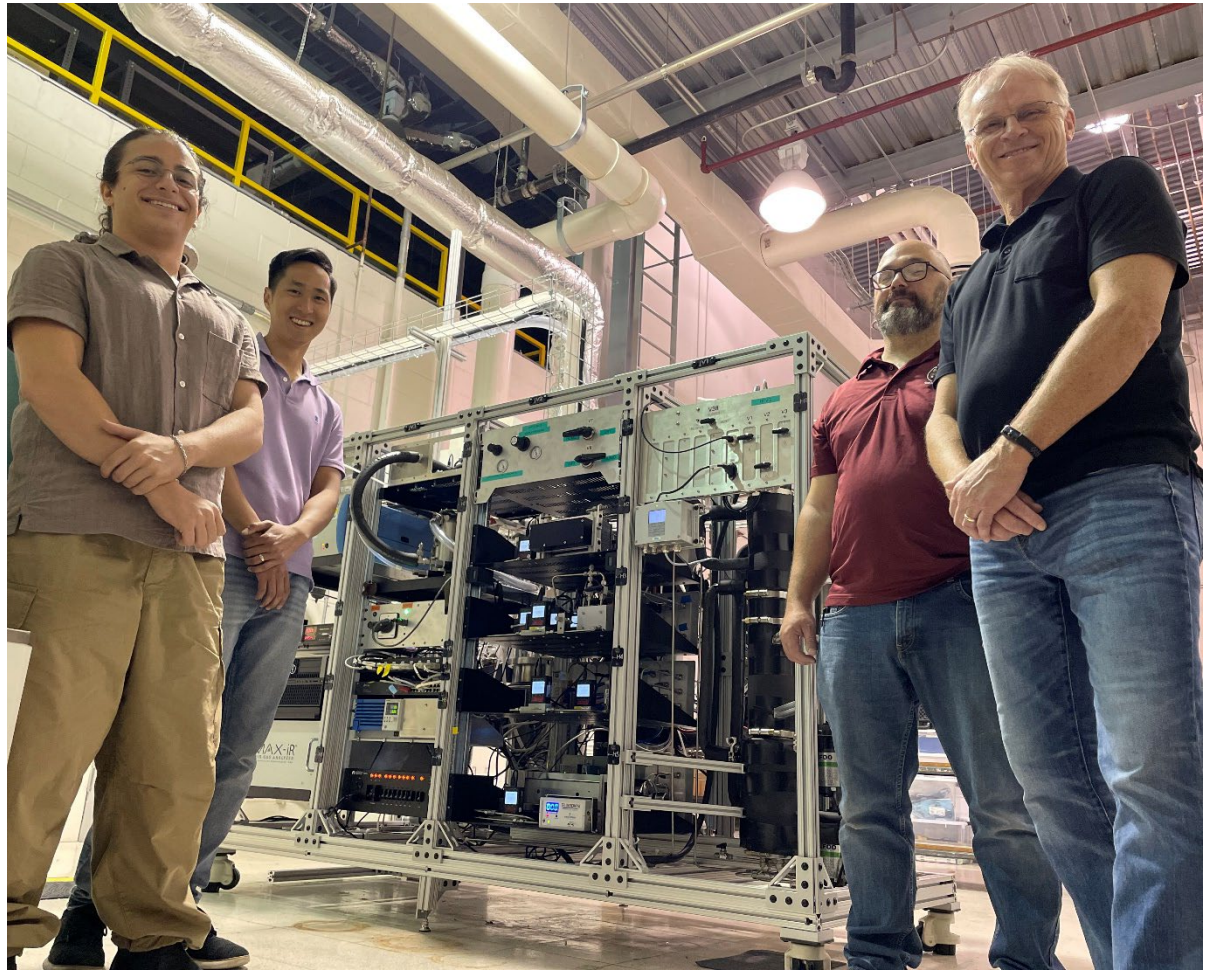
- The opinions expressed in this brief are those of the presenter and do not represent an official position of the US Government

- I have no financial relationships to disclose

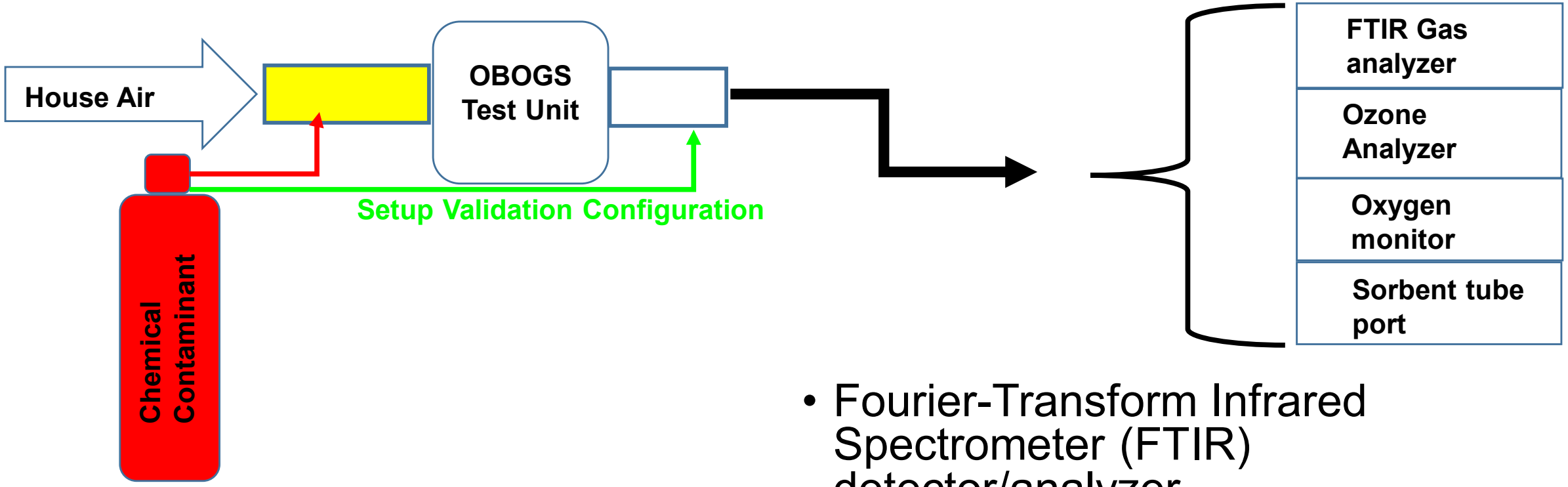
DOD Test Capability Announcement

- Works with a running OBOGS concentrator in the test stand, dry or humid conditions
- Generate sustained chemical vapors at MIL-STD-3050A Inlet Maximum concentration levels at room temperature and OBOGS inlet pressures
- Detect chemical vapors at MIL-STD-3050A Outlet Maximum concentration levels under high oxygen background conditions and pressure pulses
- Check concentrators submitted as part of engineering investigations for trace chemicals
- Generate and detect chemical vapors at multiple pressures
- Generate and detect ozone
- Separate sieve test unit for assessing chemical protectiveness of new sieve materials or chemicals not currently listed in MIL-STD-3050A (i.e., not previously tested in OBOGS)

OBOGS Chemical Challenge Test Stand



Test Rig Capability Overview



- High-flow vapor generation system
- Low-flow vapor generation system
- Ozone generation system
- Gas cylinder dilution system

- Fourier-Transform Infrared Spectrometer (FTIR) detector/analyzer
- Ozone analyzer
- Auxiliary port (sorbent tube, Photo-Ionization Detector (PID), other chemical monitor or capture device)

NOTE: Use slide show to view this chart

email suggestions for improvement

This chart illustrates DoDI 5000.85, Major Capability Acquisition model; tailoring to individual program circumstances is essential.

Major Capabilities Acquisition (Pre-Tailoring)

Acquisition & Procurement Milestones, Phases and Decision Points

See the Adaptive Acquisition Framework for other approaches to acquiring capability.

Ver. 2.1
October 21, 2022

These decision points, milestones and phases are standard elements of the Defense Acquisition System; however, MDAs, with PM input, have full latitude to tailor programs in the most effective and efficient structure possible, unless constrained by statute

Milestone & Phase Information Requirements

Statutory information requirements are shown in dark red *bold italics*.
Regulatory and best practice information requirements are shown in blue bold.
For a complete list of statutory and regulatory information requirements see the AAFDID tool.

Materiel Solution Analysis (MSA) Phase | Technology Maturation & Risk Reduction (TMRR) Phase | Engineering & Manufacturing Development (EMD) Phase | Production & Deployment (P&D) Phase | Operations & Support (O&S) Phase

MDD | A | CDD-V | DRFPRD | B | C | FRP | IOC | FOC | Full Rate Production/Deployment | Low-Rate Initial Production/ Limited Deployment | Sustainment | Disposal

MDD
- Authorizes MSA Phase Entry
- Directs conduct of *AoA*
- Designates Lead Component
- Determines Phase of Entry

Milestone A
- Approves TMRR Phase Entry
- Approves Materiel Solution & *Acquisition Strategy*
- Approves TMRR RFP release & Source Selection
- *MDAP Program Written Determinations*

CDD-V
Validation of the program requirements contained in the CDD by the requirements authority

DRFPRD
- Approves *Acquisition Strategy* & EMD RFP Release
- This review is the critical decision point in a program
- Last point at which significant changes can be made without major disruption

MS B
- Program Initiation
- Approves EMD Phase Entry
- Approves *APB* & Updated DRFPRD Information
- *MDAP Program Certifications and Determinations*

MS C
- Approves Production & Deployment Phase Entry
- Approves Updated *APB* & *Acquisition Strategy*

FRP
Approves proceeding to Full Rate Production and/or Full Deployment

MSA Phase Key Activities
- *AoA*
- Cost/Performance Trades
- Affordability Analysis
- Risk Analysis
- Develop *Acquisition Strategy*, and Other Information to Support MS A
- Select PM; establish PMO

TMRR Phase Key Activities
- Competitive Prototyping
- Technology Readiness Assessment (TRA)
- Preliminary Design Review (PDR)
- Validate Capability Development Document (CDD)
- Update *Acquisition Strategy*, and Other Information to Support DRFPRD and MS B
- Release Request for Proposal (RFP) and Conduct Source Selections for TMRR and EMD

EMD Phase Key Activities
- Developmental Testing (DT)
- Operational Assessments (OA)
- Critical Design Review
- Update *Acquisition Strategy*, APB and Other Information to Support MS C
- Update Capability Development Document (CDD)
- Release RFP and Conduct Source Selection for LRIP/FRP Prepare for Production, Fielding and Sustainment

P&D Phase Key Activities
- LRIP
- Initial Operational Test & Evaluation (IOT&E)
- Full Rate Production
- Deployment
- Performance Based Logistics (PBL) Implementation
- Update Intel/CI Products

O&S Phase Key Activities
- Overlaps P&D Phase
- Full Rate Production & Deployment Continue
- PBL Implementation Continues
- Disposal – Demilitarization and Disposal at end of useful life
- Update Intel/CI Products

CSB – Configuration Steering Board meets at least annually once established

Program Oversight & Review

Key Phase Activities

Joint Capabilities Integration and Development System (JCIDS)

Acquisition Intelligence

Contracting

Major Products

Engineering
Includes: System Engineering, Mission Engineering, and Technical Risk Assessment

Software
PM may also use the SW pathway for SW embedded in systems using the MCA pathway. See DoDI 5000.87

Test and Evaluation

Product Support Management

Financial Management
For a more detailed PPBE reference see the DAU Financial Management Platinum Card

DCAPE | AoA Study Guidance | AoA Study Plan

Capabilities Gap Assessment | Integrated Priority List | Capabilities Based Assessment (or other study) | ICD | Post AOA Review | Draft CDD

Joint Intelligence Estimate | Defense Intelligence Threat Library | Develop CIPs | Develop Threat Modules | Determine Intelligence Mission Data Dependencies

Study Contract RFP | Source Selection | Contract award(s) for MSA Phase

AoA | Materiel Solution

Mission Engineering (ME) | Mission Review: Concept Design, Trade Matrix, Mission Baseline | Concept Design Review | Initial Concept Baseline | OUSD(R&E) and DoD Components

ASR | SEP | Program Protection Plan (Includes Cybersecurity Strategy Annex)

(*The actual number and type of software builds during the program will depend on system type.)

Product Support Planning and Product Support Strategy (PSS); in Acquisition Strategy

MDA Approved *Acquisition Strategy* | ITRA | TRA

Cost-Performance Analysis and Trades | CDD | CONOPS/ OMS/ MP | VOLT | LMDP | SCRM | MDCITA

Refine CIPs & Threat Modules | Identify Intelligence Mission Data | Update as Required

Refine Requirements For Production | Update to CDD If Needed | Refine CIPs, Threat Modules and Intelligence Mission Data | Update as Required

End of Service Life Decision

TMRR RFP | EMD RFP | LRIP RFP | FRP RFP | Source Selection | Contract Awards for TMRR Phase | Contract Award for EMD Phase | Contract Award for LRIP | Contract Awards for FRP/FD/Sustainment | ECPs, Sustainment Contracts/Software Support Contracts

Within 180 Days if EVM is Required

Prototypes | Competitive Prototyping | Reass | Pre-Production Prototypes | LRIP Articles | Full-Rate Production Systems

IBR | SRR | SFR | PDR | PDR Before or After DRFPRD | PDR? | CDR | FCA | SVR | PRR | PCA

Draft Program Protection Plan | Program Protection Plan | Reassess CI, Cybersecurity, and Security Environment

Build 0.1 | Build 1.1 | Build 1.2 | Build 1.3 | Integration | Build 2.1 | Build 3.1 | Build 3.2* | PIR

TEMP | Developmental Testing of Prototypes | TRR | EOA | Developmental Testing | OA | JITC Interoperability Testing | DT&E | IOT&E | DOT&E Report on IOT&E | OTRR | LFT&E | LFT&E Report | FOT&E

LCSP | ILA | PS BCA | Demonstrate Product Support | Performance Based PS Strategy and Optimization | SR

CARD | CCE | CCP | ICE | MDAP

Appropriation Types | RDT&E | Affordability Analysis | Should Cost Targets | Full Funding in FYDP | Procurement | Operations & Maintenance

Acronyms & Abbreviations

ACAT – Acquisition Category
AoA – Analysis of Alternatives
APB – Acquisition Program Baseline
ASR – Alternative Systems Review
CARD – Cost Analysis Requirements Description
CCE – Component Cost Estimate
CCP - Component Cost Position
CDD – Capability Development Document
CDD –V – Capability Development Document Validation
CDR – Critical Design Review
CI - Counterintelligence
CIPs – Critical Intelligence Parameters
CONOPS/OM/MSP – Concept of Operations/Operational Mode Summary/Mission Profile
CSB – Configuration Steering Board
DCAPE – Director, Cost Assessment & Program Evaluation
DRFPRD – Development Request for Proposals Release Decision
DT&E – Developmental Test & Evaluation
DoDI – Department of Defense Instruction
DOT&E – Director of Operational Test & Evaluation
ECPs – Engineering Change Proposals
EMD – Engineering & Manufacturing Development
EOA – Early Operational Assessment
EVM – Earned Value Management
FCA – Functional Configuration Audit
FD – Full Deployment
FOC – Full Operational Capability
FOT&E – Follow-on Operational Test & Evaluation
FRP – Full-Rate Production
FRP/FD – Full-Rate Production / Full Deployment Decision Review
FYDP – Future Years Defense Program
IBR – Integrated Baseline Review
ICD – Initial Capabilities Document
ICE – Independent Cost Estimate
ILA - Independent Logistics Assessment
IOC – Initial Operational Capability
IOT&E – Initial Operational Test & Evaluation
ISR – In-Service Review
ITRA - Independent Technology Risk Assessment (MDAPs Only)
JIE – Joint Intelligence Estimate
JITC – Joint Interoperability Test Command
JROC – Joint Requirements Oversight Council
LCCE – Life Cycle Cost Estimate
LCSP – Life Cycle Support Plan
LFT&E – Live Fire Test & Evaluation
LMDP – Life-Cycle Mission Data Plan
LRIP – Low-Rate Initial Production
MDA – Milestone Decision Authority
MDAP – Major Defense Acquisition Program
MDCITA - Multi-Discipline Counterintelligence Threat Assessment
MDD – Materiel Development Decision
MS – Milestone
MSA – Materiel Solution Analysis
OA – Operational Assessment
OTRR – Operational Test Readiness Review
PBL – Performance–Based Life-Cycle Product Support; Performance-Based Logistics
PCA – Physical Configuration Audit
PDR – Preliminary Design Review
PIR – Post Implementation Review
PM – Program Manager
PMO – Program Management Office
PPBE – Planning, Programming, Budgeting & Execution
PRR – Production Readiness Review
PSS – Product Support Strategy
PS BCA – PS Business Case Analysis
RDT&E – Research, Development, Test & Evaluation
RFP – Request for Proposal
SCRM – Supply Chain Risk Management
SEP – Systems Engineering Plan
SRR – System Requirements Review
SFR – System Functional Review
SVR – System Verification Review
TEMP – Test & Evaluation Master Plan
TMRR – Tech Maturation & Risk Reduction
TRA – Technology Readiness Assessment
TRR – Test Readiness Review
VOLT – Validated Online Lifecycle Threat
https://www.dau.mil/tools/t/DAU-Glossary

MIL-STD-3050A Standard Test Method Target Chemicals

MIL-STD-3050A Table IV	INLET AIR CONTAMINANT	OUTLET AIR CONTAMINANT	Room Temp. State	Representative compound(s)	Comments
Acrolein	0.1 ppmv	0.05 ppmv	liquid	acetone, acrolein	
Aldehydes	1 ppmv	0.2 ppmv	liquid or gas	acetalydehyde, propanal	
Aromatics	10 ppmv	0.1 ppmv	liquid	toluene, xylenes	
Carbon Dioxide	5000 ppmv	500 ppmv	gas	carbon dioxide	
Carbon Monoxide	50 ppmv/250 ppmv (Navy)	10 ppmv	gas	carbon monoxide	
Cobalt	0.1 mg/m^3	0.025 mg/m^3	solid	N/A	
Ethanol	1000 ppmv	500 ppmv	liquid	ethanol	
Fluorine (as HF)	0.1 ppmv	0.05 ppmv	liquid	HF	recommend separate filter testing
Halogenated Solvents	2 ppmv	0.2 ppmv	liquid or gas	dichloromethane, trichloroethylene	
Hydrogen Peroxide	1 ppmv	0.5 ppmv	liquid solution	hydrogen peroxide	material incompatible with zeolites
Methyl Alcohol	200 ppmv	100 ppmv	liquid	methyl alcohol	
Methyl Bromide	20 ppmv	1 ppmv	gas	methyl bromide	
Nickel	0.5 mg/m^3	0.125 mg/m^3	solid	N/A	
Nitrogen Oxides	5 ppmv	0.1 ppmv	gas	nitrogen dioxide	
Oil Breakdown Products	1 ppmv	0.1 ppmv	particles	N/A	
Oil and Particulate Matter	2 mg/m^3	0.2 mg/m^3	particles	N/A	
Ozone	0.1 ppmv	0.05 ppmv	gas	ozone	
Sub-micron particles	0.5 mg/m^3	0.05 mg/m^3	particles	N/A	
Total hydrocarbons	250 ppmv	25 ppmv	liquid or gas	n-heptane, n-octane	
Unsaturated hydrocarbons (alkenes, alkynes)	2 ppmv	0.2 ppmv	liquid or gas	ethylene, propyne	
Vapor Phase Water	≤ 95% non-condensing	-4° F dew point	liquid	N/A	

ppm : parts per million by volume

Challenges Addressed

- ✓Low target concentrations
  - Difficult to hold consistent vapor concentration
  - Signal-to-noise ratios in detection equipment
- ✓Low vapor pressures in some target chemicals
  - COTS vapor generation insufficient
  - Maintain vapors at room temperature to avoid condensation during testing
- ✓High oxygen concentrations can reduce sensitivity of industrial gas analyzers
  - O_2 raises the limit of detection during testing with running OBOGS
- ✓Pressure pulses from running OBOGS
  - Less stable baselines
  - Reduced signal-to-noise ratio

Vapor Generation Method for Each Target

MIL-STD-3050 Chemical Designation	Chemical Species	Maximum Allowable Inlet Conc. (ppmv)	Maximum Allowable Outlet Conc. (ppmv)	Vapor Generator Method
Substitute for acrolein	Acetone	0.1	0.05	Gas Dilution
Explicitly Identified	Carbon Dioxide	5000	500	Gas Dilution
Explicitly Identified	Carbon Monoxide	50	10	Gas Dilution
Explicitly Identified	Ethanol	1000	500	HFVG
Explicitly Identified	Methanol	200	100	HFVG
Explicitly Identified	Methyl Bromide	20	1	Gas Dilution
Explicitly Identified	Ozone	0.1	0.05	Ozone Generator
Chemical Class: Aldehydes	Acetaldehyde	1	0.2	Gas Dilution
Chemical Class: Aromatics	Toluene m-Xylene	10 10	0.1 0.1	LFVG HFVG
Chemical Class: Halogenated Solvents	Dichloromethane Trichloroethylene	2 2	0.2 0.2	Gas Dilution LFVG
Chemical Class: Nitrogen Oxides	Nitrogen Dioxide Nitrous Oxide	5 5	0.1 0.1	Gas Dilution
Chemical Class: Total Remaining Hydrocarbons	n-Octane	250	25	HFVG
Chemical Class: Unsaturated Hydrocarbons (alkenes, alkynes)	Ethylene Propyne	2 2	0.2 0.2	Gas Dilution Gas Dilution

ppm : parts per million by volume

Gas Dilution System OBOGS Inlet Concentrations

Bleed Air Temperature Set Point (°C)	50
Humidity Set Point ([g/m^3])	8.1
Bleed Air Pressure (PSIG)	50

Chemical	Goal Concentration (ppm)	Measured and Corrected Concentration (ppm)	Difference from Goal (%)	Product Oxygen (%)
Acetone	0.1	0.088±0.002	12.8	92.82
Propyne	2	1.83±0.01†	9.0	93.18
Nitrous Oxide	5	4.483±0.001	10.9	93.65
Ethylene	2	1.750±0.003†	13.3	93.70
Carbon Monoxide	50	46.8±0.6†	6.7	93.84
Acetaldehyde	1	0.93±0.01	7.6	94.11
Nitrogen Dioxide*	5	4.91±0.01	1.8	92.56
Dichloromethane	2	1.943±0.003	2.9	93.85
Methyl Bromide	20	19.10±0.02†	4.6	94.74
Carbon Dioxide	5000	4885.4±1.4†	2.3	94.21

† Denotes calibration curve applied.
* Denotes that a chemical was run under dry, not humid, conditions.

Gas Dilution System OBOGS Outlet Concentrations

Bleed Air Temperature Set Point (°C)	50
Humidity Set Point ([g/m^3])	8.1
Bleed Air Pressure (PSIG)	50

Chemical	Goal Concentration (ppm)	Measured and Corrected Concentration (ppm)	Difference from Goal (%)
Acetone	0.05	0.050±0.003	0.6
Propyne	0.2	0.197±0.010†	1.3
Nitrous Oxide	0.1	0.1001±0.0004†	0.09
Ethylene	0.2	0.200±0.005†	0.18
Carbon Monoxide	10	8.86±0.92†	12.0
Acetaldehyde	0.2	0.206±0.008	2.8
Nitrogen Dioxide*	0.1	0.0918±0.0007	8.6
Dichloromethane	0.2	0.223±0.004	10.7
Methyl Bromide	1	0.93±0.02†	7.7
Carbon Dioxide	500	523.3±3.6	4.5

† Denotes calibration curve applied.
* Denotes that a chemical was run under dry, not humid, conditions.

Low-Flow Vapor Generation System OBOGS Inlet Concentrations

Bleed Air Temperature Set Point (°C)	50
Humidity Set Point ([g/m^3])	8.1
Bleed Air Pressure (PSIG)	50

Chemical	Goal Concentration (ppm)	Measured Concentration (ppm)	Difference from Goal %	Product Oxygen %
Trichloroethylene	2	2.301±0.001†	13.4	93.82
Toluene	10	9.533±0.015	4.8	93.40

† Denotes calibration curve applied.

Low-Flow Vapor Generation System OBOGS Outlet Concentrations

Bleed Air Temperature Set Point (°C)	50
Humidity Set Point ([g/m^3])	8
Bleed Air Pressure (PSIG)	50

Chemical	Goal Concentration (ppm)	Measured Concentration (ppm)	Difference from Goal %
Trichloroethylene	0.2	0.200±0.002†	0.2
Toluene	0.1	0.097±0.006	3.1

† Denotes calibration curve applied.

High-Flow Vapor Generation System OBOGS Inlet Concentrations

Bleed Air Temperature Set Point (°C)	50
Humidity Set Point ([g/m^3])	8.1
Bleed Air Pressure (PSIG)	50

Chemical	Goal Concentration (ppm)	Measured Concentration (ppm)	Difference from Goal %	Product Oxygen %
Methanol	200	219.7±0.1†	9.4	93.92
Ethanol	1000	866.58±0.15†	14.3	94.41
n-Octane	250	255.4±0.2†	2.1	94.70
m-Xylene	10	10.69±0.01	6.7	93.44

† Denotes calibration curve applied.

High-Flow Vapor Generation System OBOGS Outlet Concentrations

Bleed Air Temperature Set Point (°C)		50	
Humidity Set Point ([g/m^3])		8.1	
Bleed Air Pressure (PSIG)		50	
Chemical	**Goal Concentration (ppm)**	**Measured Concentration (ppm)**	**Difference from Goal %**
Methanol	100	104.00±0.04†	3.9
Ethanol	500	465.02±0.24†	7.3
n-Octane	25	25.18±0.01†	0.7
m-Xylene	0.1	0.109±0.003	8.2

† Denotes calibration curve applied.

Ozone Generation System OBOGS In/Outlet Concentrations

Bleed Air Temperature Set Point (°C)	50
Humidity Set Point ([g/m^3])	8.1
Bleed Air Pressure (PSIG)	50

Product Verification Test*

Goal Concentration (ppb)	Measured Concentration (ppb)	Difference (BA-Prod) %	Difference from Goal %
50	BA – 54.57±0.12 Prod – 50.18±0.11	8.4	BA – 8.7 Prod – 0.4

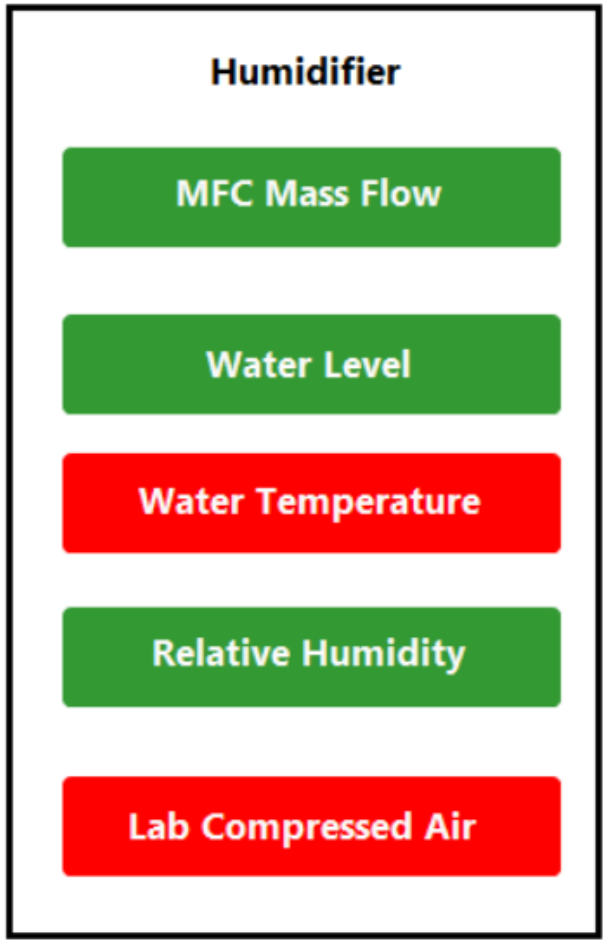
Ozone Generation Bleed Air Test

Goal Concentration (ppb)	Measured Concentration (ppb)	% Difference from Goal	Product Oxygen %
100	109.55±0.14	9.1	93.34

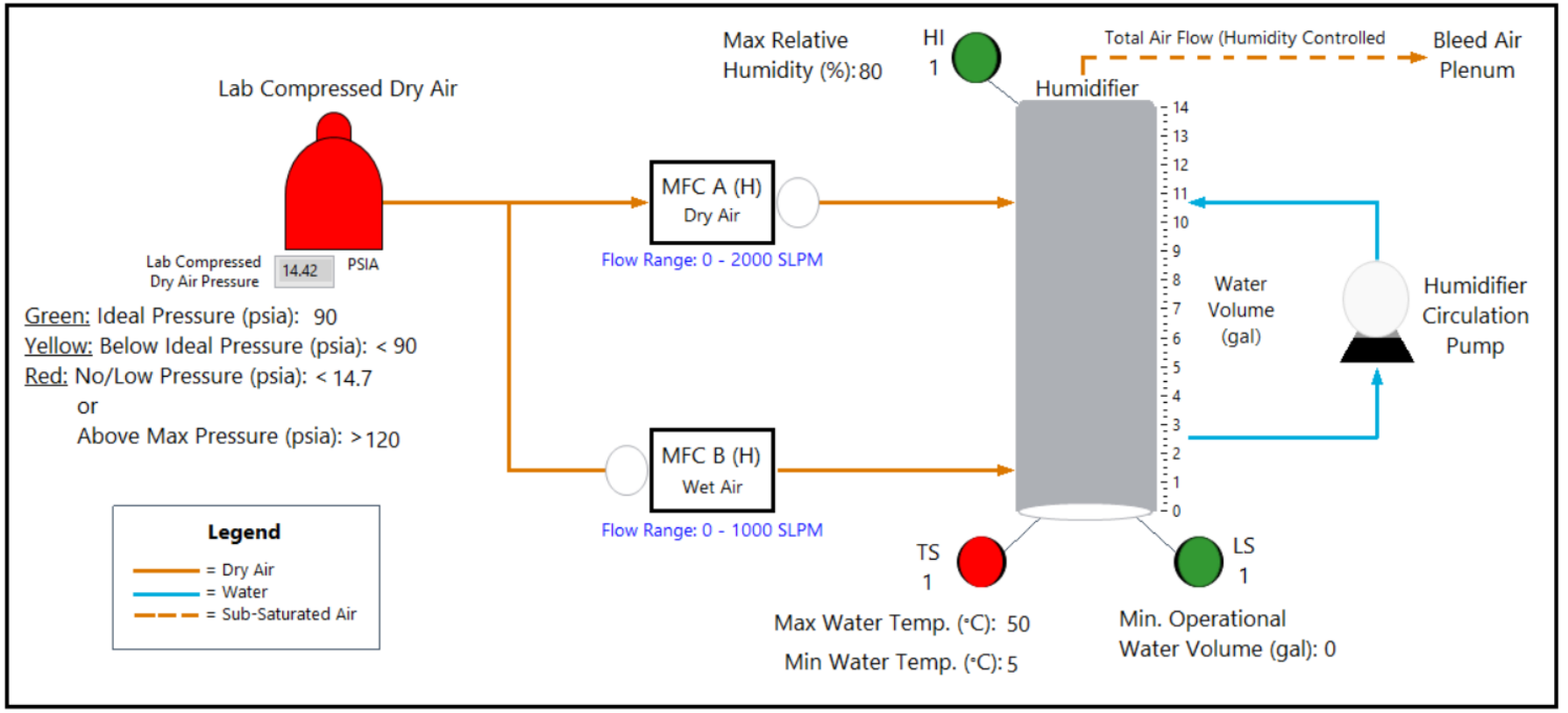
BA : Bleed Air
Prod: Product Air
ppb: parts per billion

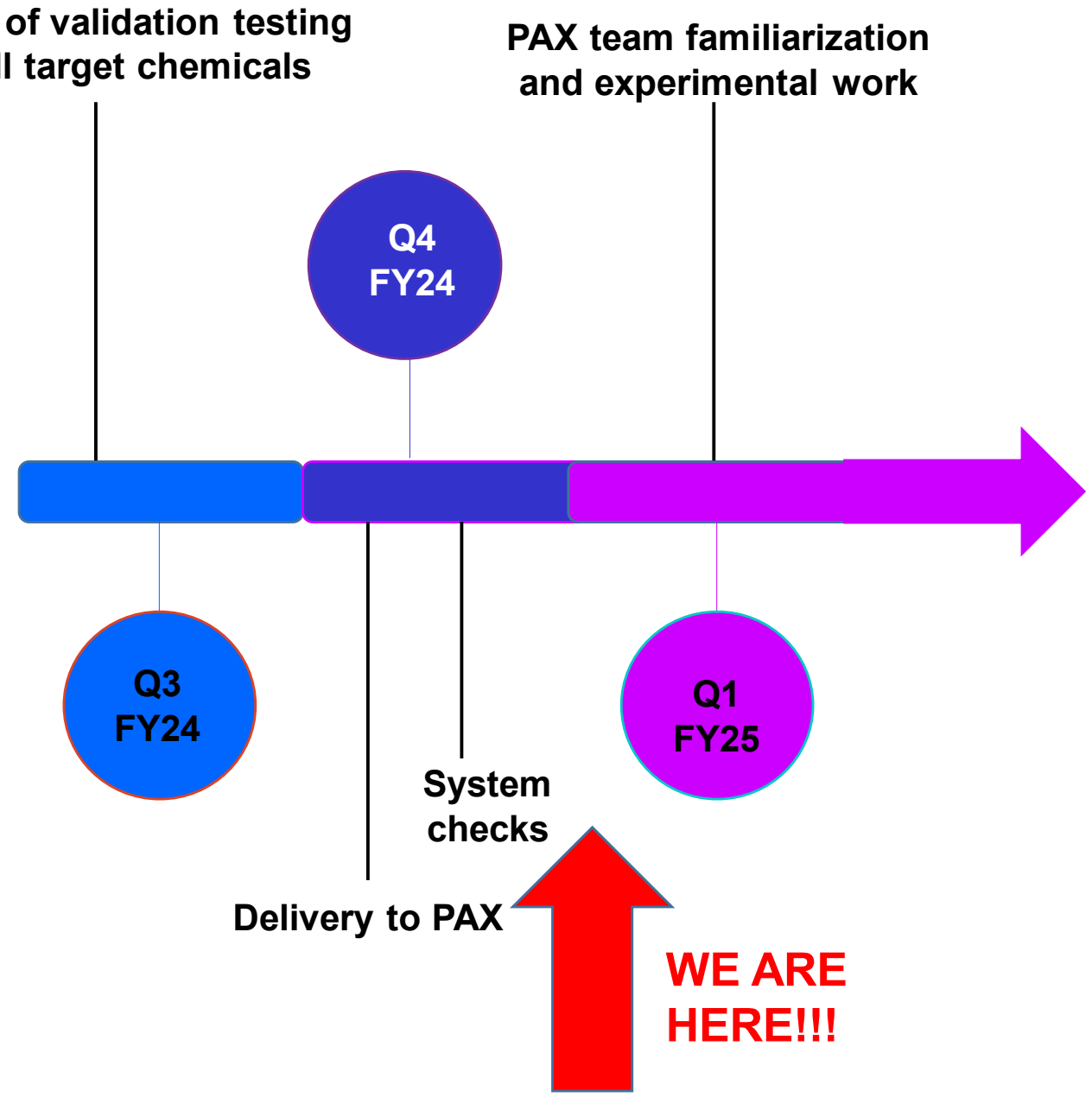
A Look at the Control Software Design and Graphical User Interface (GUI)

Notifications Tab on GUI



Humidifier subsystem page





Bottom Line In Back (BLIB)

- OBOGS Chemical Challenge Test Stand is complete and installed at NAS Patuxent River
- FY 25 efforts will focus on finalizing a standardized test method and test cost determination
- Interested parties should contact Dr. Eller for assistance with tours or for testing/R&D discussions

Our most sincere thanks to

- Asymmetric Operations Sector Applied Chemistry and Physics at the Johns Hopkins University Applied Physics Laboratory
- NAWCAD Aeromedical and Life Support Division
- Naval Undergraduate Flight Training Systems Program Office
- NAWCAD Human Systems Engineering Department

- OSCG 2024 attendees

Questions?

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