Materials Fire Test Method Development

Technical Readiness Assessment

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Development Project Technical Readiness

Agenda:

- Technical Readiness Levels (NASA)
- TRL Criteria for Test Method Developmental Activities
- Current Assessment of Test Method Development Activities
- Recommended Next Steps

Developmental Project Technical Readiness

- Technical Readiness assessment provides a maturity level to help define next steps for a developmental project.
- Overall goal – gated approach to assess Technology Ready Level (TRL) and ensure project is ready to proceed to next level of development. Ultimate goal is to reach “Production Ready” for effective incorporation into a production environment.
- Technology evaluations at the TRL gate and technology maturity level review must address whether or how to proceed with technology development, and to determine if a technology is ready for incorporation into production product or process.
- Utilize the National Aeronautics and Space Administration (NASA)/Department of Defense (DoD) technology maturity stages.
  http://www.hq.nasa.gov/office/codeq/trl/trl.pdf

Developmental Project Technical Readiness

NASA Technology Readiness Levels Summary

TRL 1	Basic principles observed and reported
TRL 2	Technology concept and/or application formulated
TRL 3	Analytical and experimental critical function and/or characteristic proof-of concept
TRL 4	Component and/or breadboard validation in laboratory environment
TRL 5	Component and/or breadboard validation in relevant environment
TRL 6	System/subsystem model or prototype demonstration in a relevant environment (ground or space)
TRL 7	System prototype demonstration in a space environment
TRL 8	Actual system completed and “flight qualified” through test and demonstration (ground or space)
TRL 9	Actual system “flight proven” through successful mission operations

How would this be translated for a flammability test method developmental project?

Developmental Project Technical Readiness

Flammability Test Method/Equipment TRLs (Derived from NASA TRL)

MATURITY LEVEL

Discovery

Feasibility

Practicality

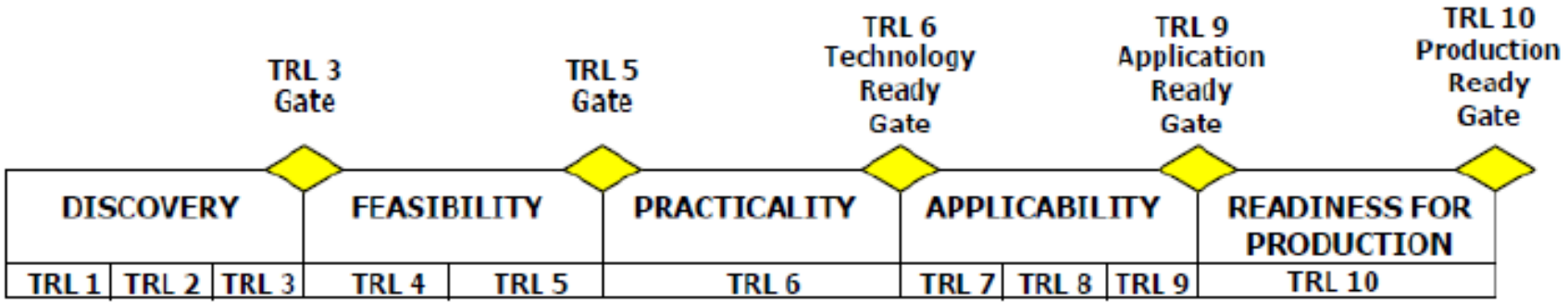
Applicability

Production Readiness

TRL 1	Basic principles/concept of test equipment and procedure defined.
TRL 2	Test method concept formulated and defined by draft standards.
TRL 3	Analytical and experimental critical function and/or characteristic proof-of concept (e.g. by modifying old/existing equipment)
TRL 4	New prototype equipment validation in laboratory environment (robustness)
TRL 5	Updated prototype equipment validation in relevant production environment (repeatability). Documented test guidance framework.
TRL 6	Multiple prototypes validation in relevant environment (reproducibility)
TRL 7	Finalized prototype equipment demonstation on range of production configurations. Documented test guidance defined.
TRL 8	Final test equipment drawigns released, equipment built to the standards, and “qualified” through test and demonstration. Documented test guidance finalized.
TRL 9	Multiple production units verified by successful round robin testing.

Developmental Project Technical Readiness

Five Maturity Level Stages:



Discovery	Concept for new test method complete
Feasibility	Preliminary equipment and test method defined (robustness & repeatability)
Practicality	Design and construction complete and tested (repeatability)
Applicability	Technology verified, scaled, and proven repeatable in production environment.
Production Readiness	Complete technology validated and integrated into the design and requirements. Requirements defined and all documentation completed to ensure implementation into production can occur.

Developmental Project Technical Readiness

- The following readiness evaluation categories are used for both technology maturity stages and TRL gates:

1. Consistency with goals & strategies
2. Technical validity
3. Cost, benefit, and risk assessment
4. Competitive technology assessment (alternative solutions)
5. Technology scalability for production use
6. Impact of technology
7. People and organizational readiness
8. Technology user endorsement
9. Technology information (documentation)

Developmental Project Technical Readiness

Technical Readiness Assessment

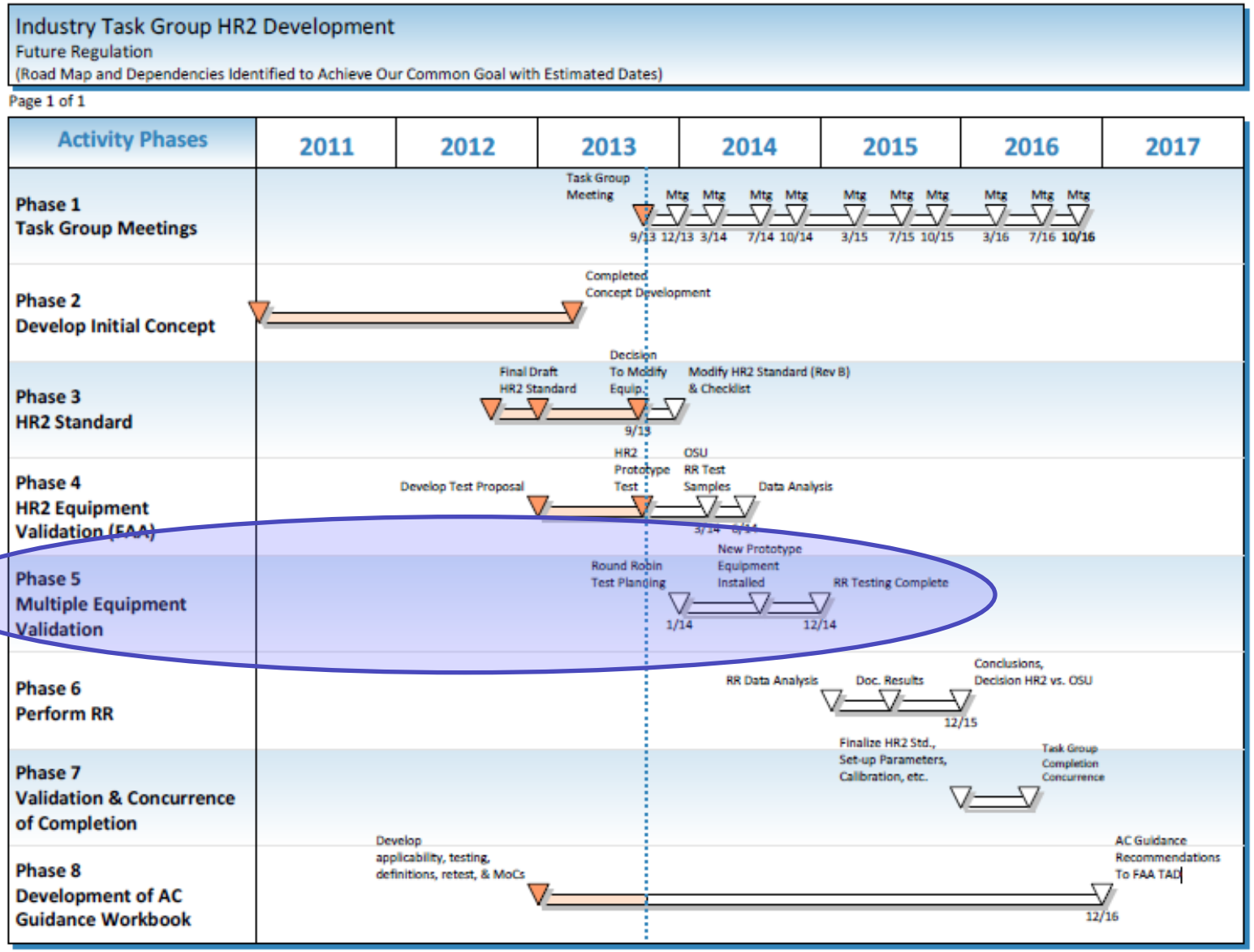
Materials Fire Test Working Group Activities Technology Readiness Level			Status / Next Steps Summary
Task Group	**Focus Area**	**Current Maturity Phase (Working TRL level)**	
Cargo Liner	▪ Sonic Burner Test Method	Feasibility (TRL 6)	▪ Inter-lab variability exists ▪ Develop plan for RR testing ▪ Benchmark materials to ensure equivalency of new burner to Park burner (reduce future risk) ▪ Define standard and guidance
Thermal Acoustic Insulation	▪ RP2 Test Method	Discovery Phase (TRL 2)	▪ Define RP2 test method standard. ▪ Competitive assessment with other methods – determine if current method acceptable as is. ▪ Construct prototype ▪ Plan round robin plan
Heat Release &Smoke	▪ OSU Round Robin	Practicality (TRL 7)	▪ RR analysis is in-work. ▪ Define recommendations for AC guidance.
	▪ HR2 Development	Feasibility (TRL 4)	▪ Prototypes being fabricated (Marlin Engr and Govmark) ▪ Development of DOE test matrix needs priority.
	▪ Heat Flux Gage Standard	Discovery (TRL 3)	▪ Prototype to be fabricated ▪ Define found robin test plan
Vertical Flame Propagation (Composite Skin, Ducting, Wiring)	▪ Test Rig Validation - Benchmark Materials	Feasibility (TRL 5)	▪ Develop DOE and RR testing analysis. ▪ Benchmark current materials. Collaborate with Electrical and ECS. Develop pas/fail criteria
	▪ AC Guidance development	Discovery Phase (TRL 2)	▪ Develop compliance examples (ECS duct example) ▪ Need budget/resources defined to support.

Developmental Project Technical Readiness

- Next Steps for Working Group/Task Groups:

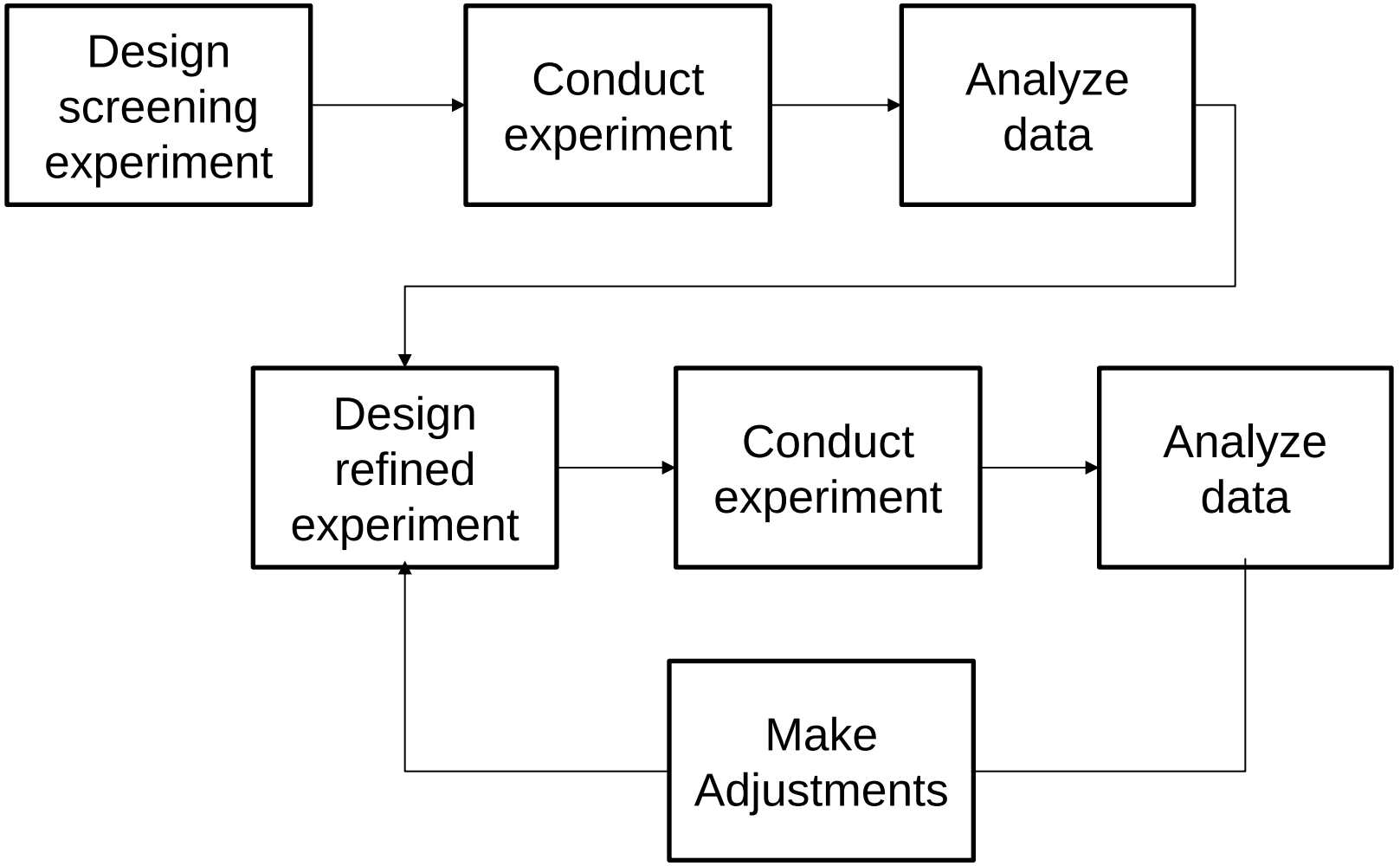
1) Have dialogue on TRL assessment approach.
2) Refine criteria to address test method development and AC guidance development.
3) Task Groups to perform Technical Readiness assessment of each project and define specific next steps (DOE, Analysis, etc).
4) Develop overall project schedules for each activity, to reach Production Ready (Test method is ready to be addressed in a new AC, NPRM, Policy).

HR2 Project Schedule – June 2013 (Example Schedule)



Statistical Design and Analysis of Experiments in the Context of FTWG

Experimental Strategy



Screening Experiment

- Develop list of all known factors (controllable and uncontrollable)– utilize knowledge base of industry experts
- Determine the desired factor(s) to study – screening experiments generally target a larger number of factors at few levels
- The goal is to gain a basic understanding of the system and relative magnitude of the effect of each factor
- Analyze the data and make conclusions

Refined Experiment

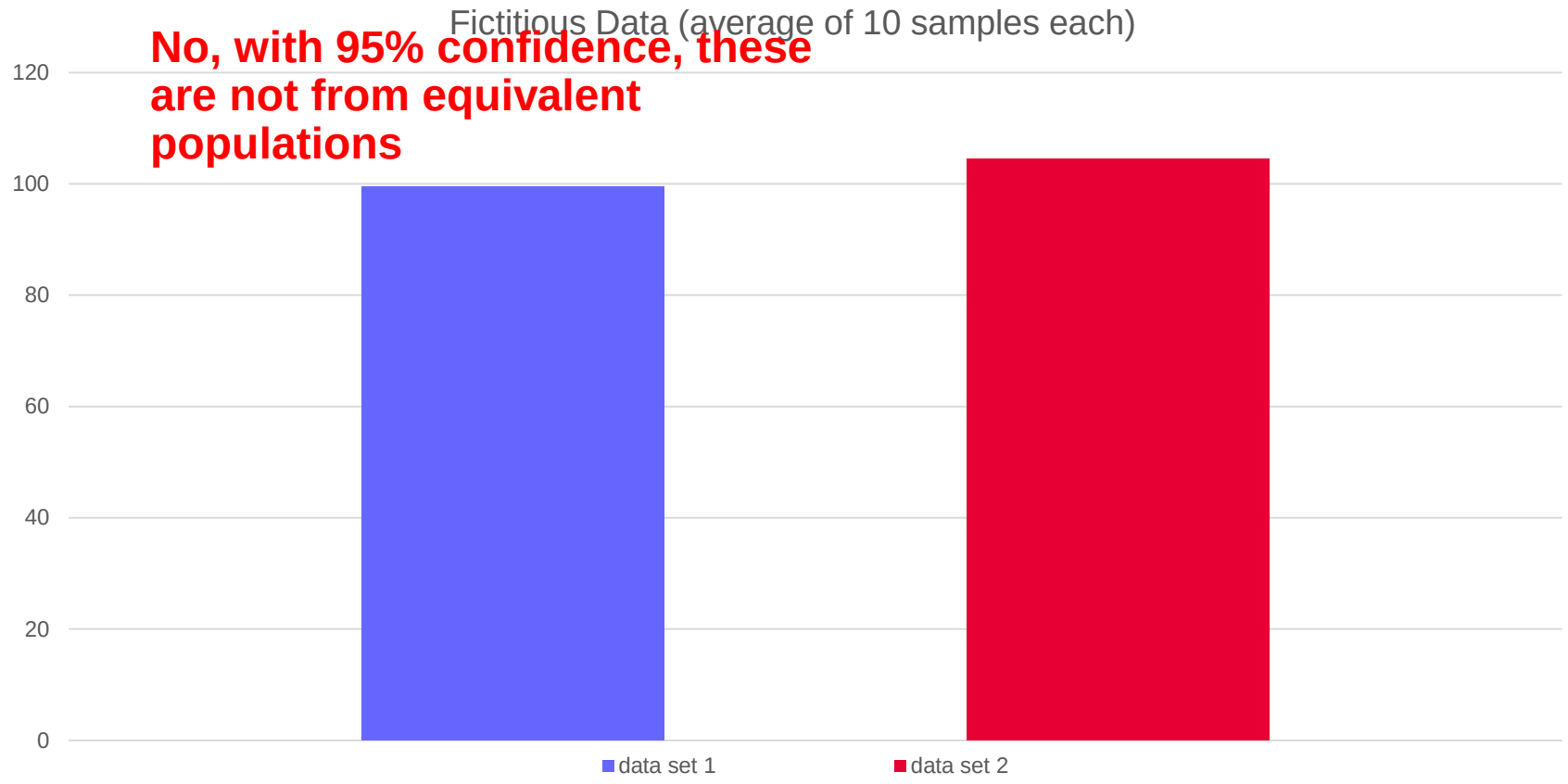
- Utilize knowledge of the system from the screening experiment
- Select factors that showed a significant effect in the screening experiment to be studied further
- Analyze the data and make conclusions/recommendations
- Make adjustments to the system or experiment
- Iterate process until satisfactory results are obtained

Notes

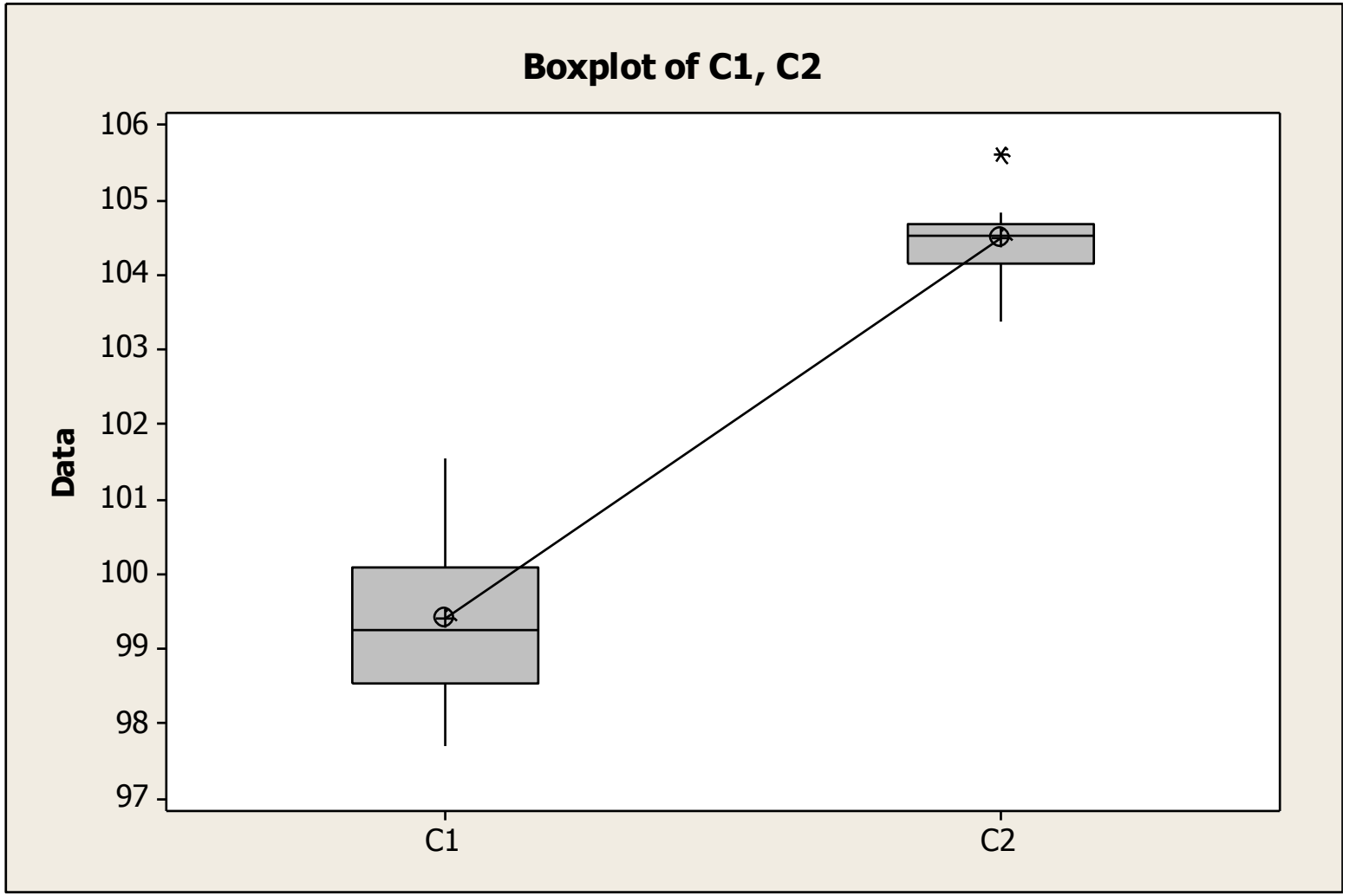
- All controllable factor not being studied should be held constant
- All uncontrollable factors should be measured and recorded, if possible
- Randomize coupons and run order to minimize the effect of unknown variables
- Utilize full factorial or fractional factorial designs rather than OFAT (one-factor-at-a-time)
  - OFAT does not obtain information on interactions between factors
  - Factorial designs vary multiple factors at once, enabling information to be gathered about interactions between factors

Notes on the Use of Mean for Comparison

- Can we conclude that the two data sets below are from “equivalent” populations?

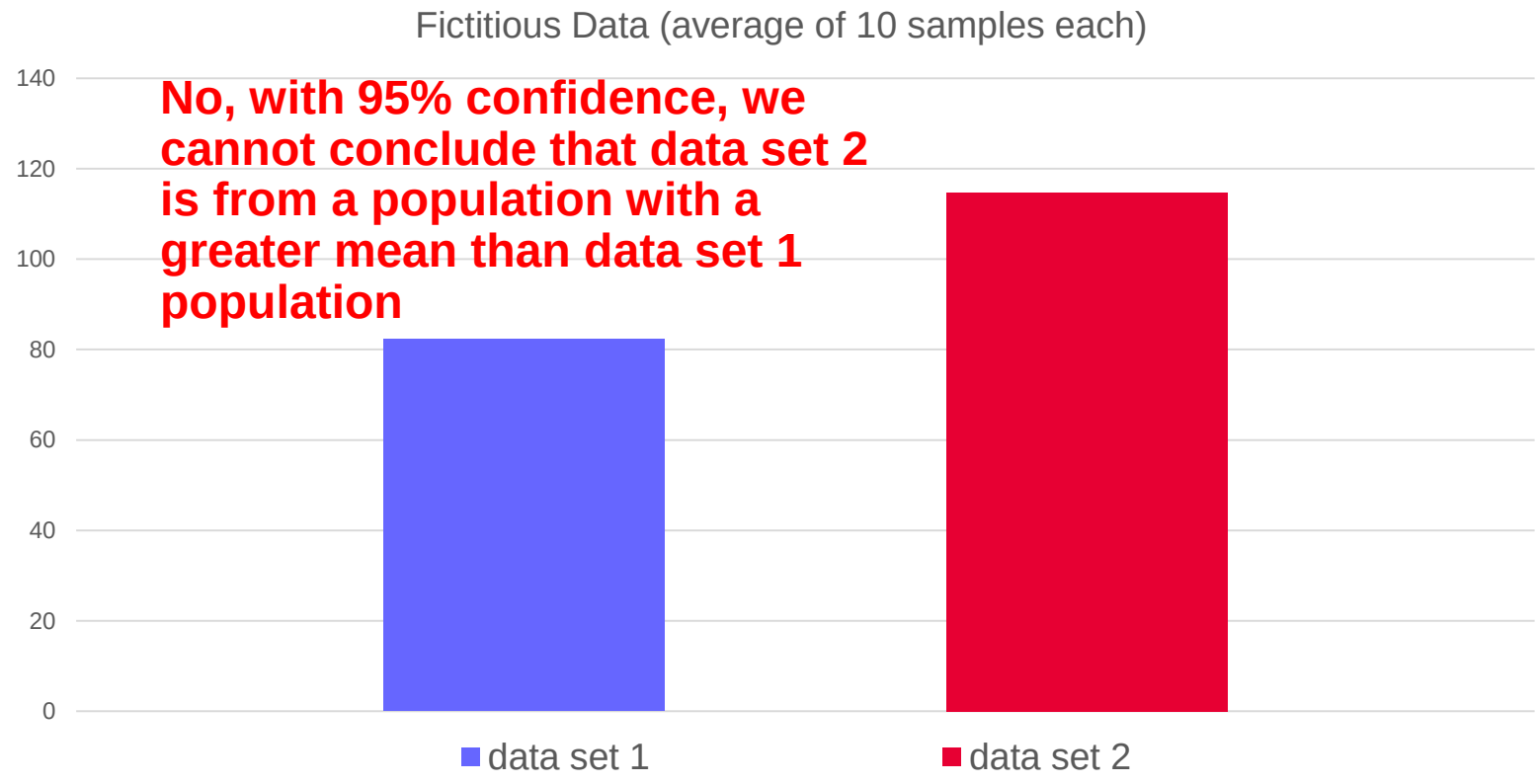


Box Plot Representation of Data

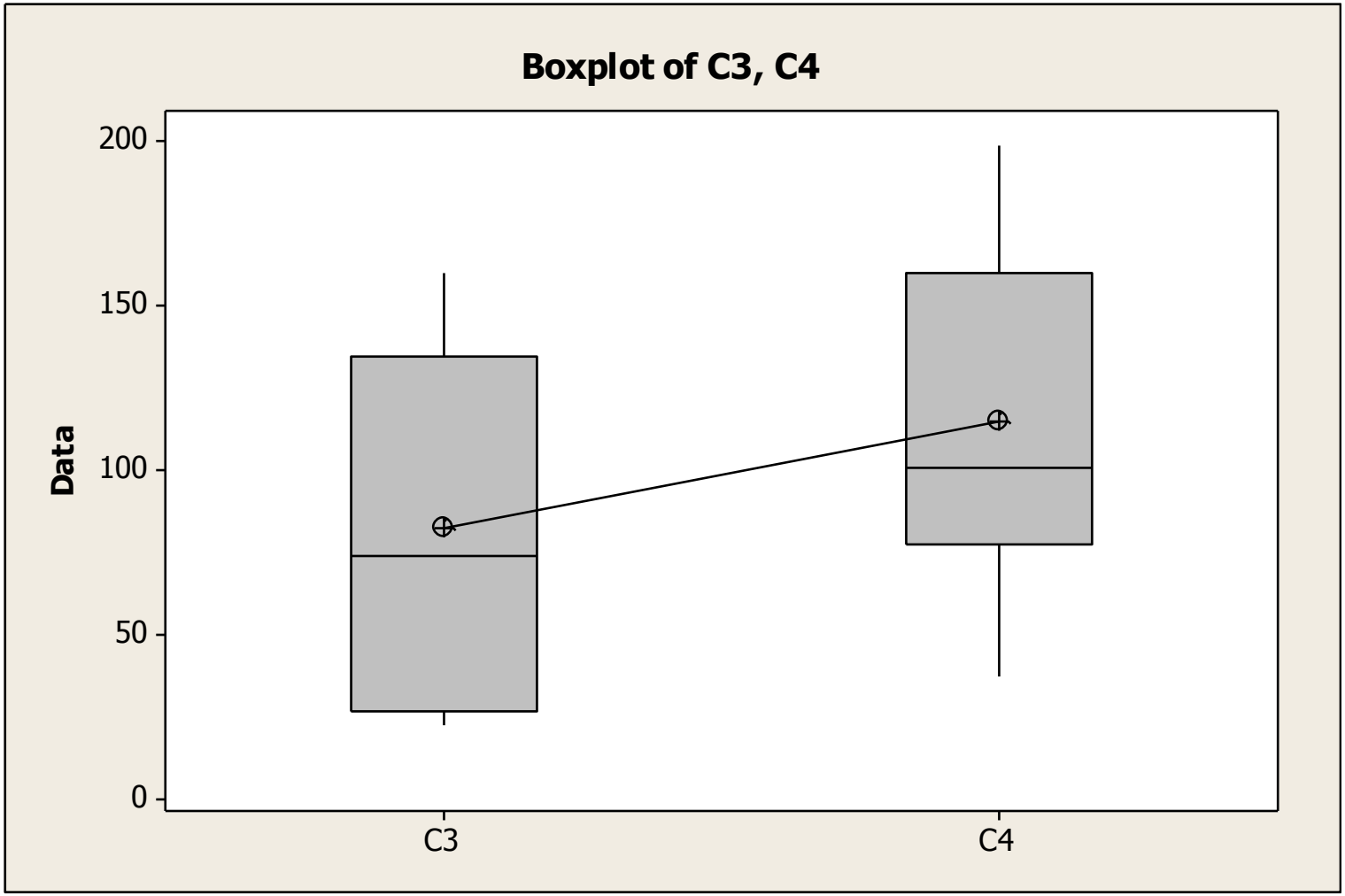


Notes on the Use of Mean for Comparison

- Can we conclude that data set 2 comes from a population with a higher mean?



Box Plot Representation of Data



Conclusion

- Utilizing Design of Experiments (DOE) methodologies produces the most efficient use of testing resources
- Means of sample sets should be used in conjunction with other sample statistics to make meaningful inferences about the respective populations
- Hypothesis testing should be used to compare data.

Questions?