Cargo Liner
Park Oil Burner vs. Sonic Burner
Comparison Testing

International Aircraft Materials Fire Test Working Group
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Boeing: Matt Anglin, Lyle Bennett, Dan Slaton, Hannah Thomas

Park/Sonic Comparison

- **Objective**
  - Perform head-to-head cargo liner burnthrough testing using Park and Sonic burners
  - Compare burnthrough times to determine degree of matching between the 2 burner types

- **Background**
  - FAA Tech Center, with input from the aerospace flammability test community, has been developing the Sonic burner as an option to legacy oil burners (Park, Carlin, Lennox….) for cargo liner burnthrough testing
    - Park oil burners can no longer be purchased--Sonic burner for new lab installations & legacy burner replacement
    - Development work through FAA Materials Fire Test Working Group (Project Lead: Tim Salter, FAA Tech Ctr)
    - End-use burner application: certification testing of cargo liner materials and constructions
  - Boeing/OEMs have considerable certification testing history using legacy oil burners (e.g. Park)
    - Existing designs (previously certified) should be insensitive to test burner type
    - For future testing of slight design changes using Sonic burner, need to ensure Sonic burner is similar to but not more severe than Park burner

Park/Sonic Comparison

- **Experimental Details**
  - Test Materials* (5 coupons of each material for each burner)
    - Polyacrylonitrile (PAN) felt
    - Polyimide (PI) foam (1 lb/ft^3)
    - Polyimide (PI) foam (2 lb/ft^3)
    - Foam with Kapton® film
    - Carbon Fiber/Phenolic Pre-preg
    - Aluminum (Al) sheet** (6061-T6, 0.032” thick)—sidewall configuration
      - *Materials intentionally chosen for burnthrough behavior and are *not* representative of true cargo liners
      - **Only 3 coupons for each burner because of long burnthrough times
  - Test Procedure
    - Burnthrough testing (time-to-burnthrough) for a given material was performed in parallel using both burners
      - Pro: Ensures homogeneity of certain environmental parameters (ambient temperature, pressure, humidity,…), reduces test costs & overall cumulative test time
      - Con: Requires 2 different test cells (Park: “cell 3,” Sonic: “cell 1”) with associated differences in airflow dynamics. Matched airflows using anemometer measurements and adjusting exhaust flows.
  - Statistical Data Analysis
    - For each material, single factor/2-level “analysis of variance” (ANOVA) at 5% significance level

FAA Large Test Cell

Park/Sonic Comparison: Illustrative Data Analysis (PAN Felt)

One-way ANOVA: Burnthrough Time (sec) versus Burner

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Source   DF     SS     MS      F      P
Burner    1    209    209   0.17  0.691
Error     7   8526   1218
Total     8   8735

                          Individual 95% CIs For Mean Based on
                          Pooled StDev
Level   N    Mean  StDev  -------+---------+---------+---------+--
Park    4  403.50  31.71    (---------------*----------------)
Sonic   5  393.80  37.11  (--------------*-------------)
                          -------+---------+---------+---------+--
                               375       400       425       450

Pooled StDev = 34.90

Grouping Information Using Tukey Method
Burner  N    Mean  Grouping
Park    4  403.50  A
Sonic   5  393.80  A

Means that do not share a letter are significantly different.
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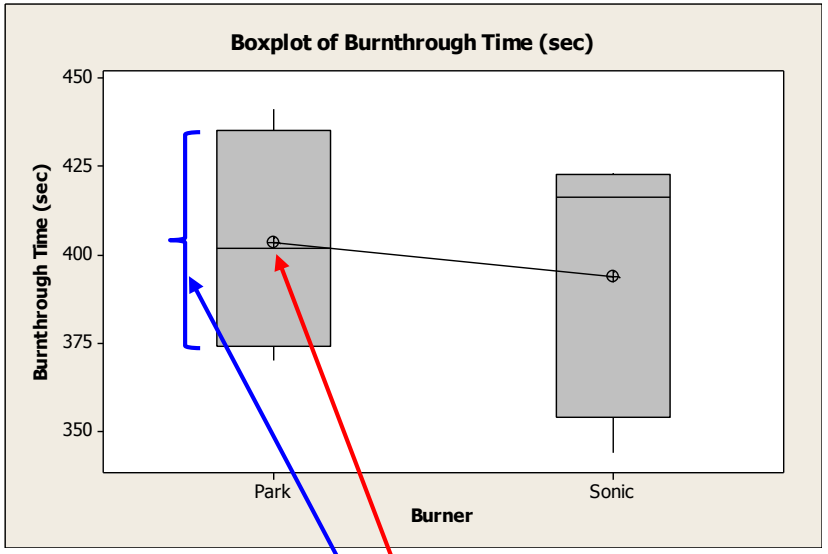


Important Values

- Average (mean)
- Variation

Notes on Statistical Analysis

- Use aggregated information instead of individual observations
- Use measures of both “center” (mean, median) and “spread” (std dev) of data sets
- Use quantitative analysis (ANOVA…) instead of qualitative analysis for data set comparisons
- Result: Higher probability of reaching correct conclusions from the data

Park/Sonic Comparison

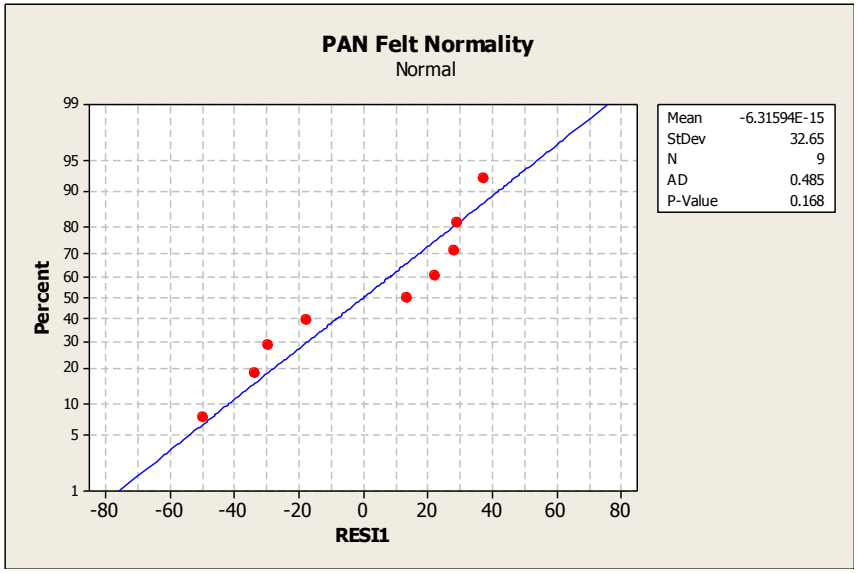
- **Executive Data Summary**

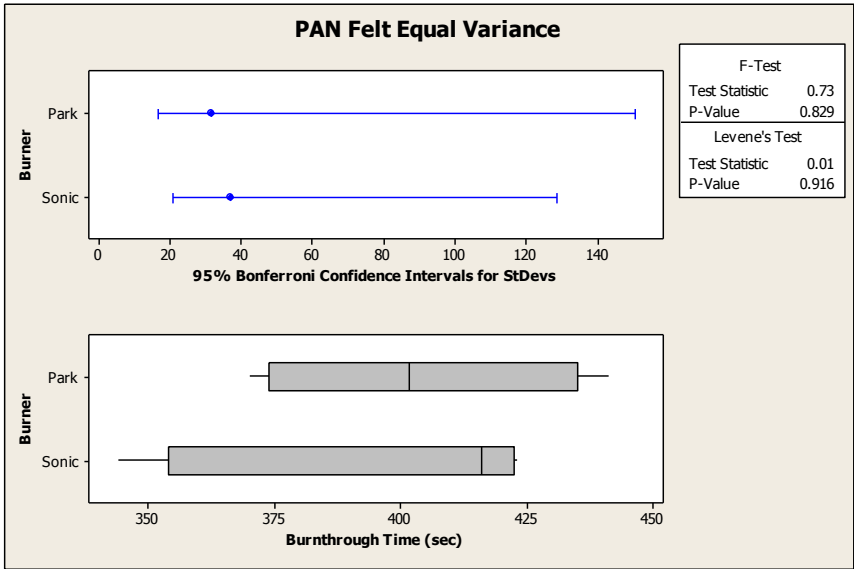
Material	Average Burnthrough Time (sec)		Sonic "similar to but not more severe than" Park? (Y/N)
	Park	Sonic	
PAN Felt	404	394	Y
PI Foam (2 PCF)	56	81	Y
Foam with Kapton	22	35	Y
PI Foam (1 PCF)	27	35	Y
Carbon Fiber/Phenolic Pre-preg	886	959	Y
0.032" Al sheet	1755	2090	Y

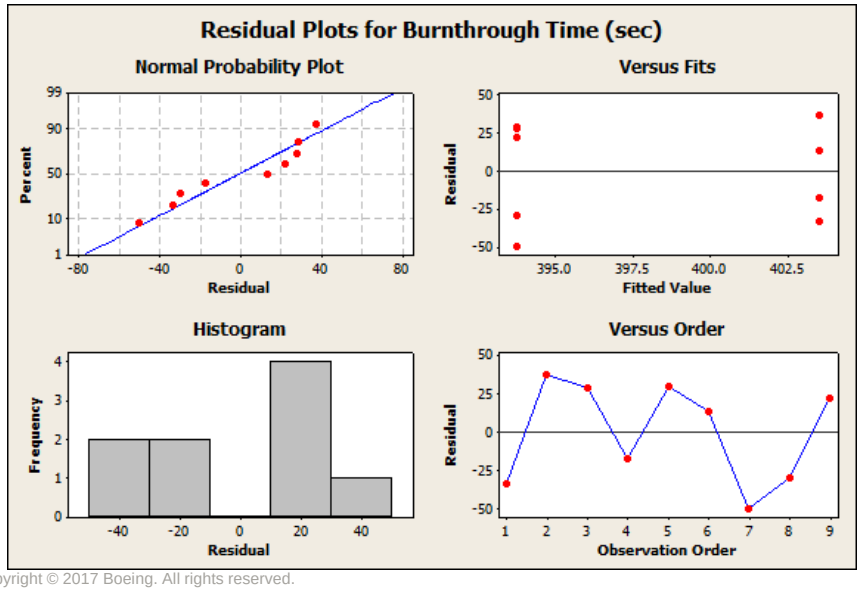
- **Conclusion**
  - Sonic well-matched to Park burner in actual burnthrough performance
    - Snapshot in time based on a limited sample set over the range of materials tested
    - Assumes frozen Sonic burner hardware configuration
      - FAA TC development work on burner test cell air flow dynamics in progress

Backup

Park/Sonic Comparison: PAN Felt







Validation of ANOVA Assumptions

- Normality satisfied
- Homogeneous variance satisfied