Data Sets Used in Statistical Methods for Reliability Data

Second Edition

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This collection contains csv files for the data sets used in the examples and exercises of Meeker, Escobar, and Pascual (2021) (hereafter SMRD2). This document describes the original source of the data set (if it appeared in the literature before appearing in SMRD1 or SMRD2), provides some background for the data set, and points to where it is used in SMRD2.

The csv data files and this document are available from the SMRD2 webpage at
https://www.wiley.com\go\meeker\reliability2e
and at https://github.com/wqmeeker/SMRD2Data.git.

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1. `AdhesiveBondA.csv`
   These adhesive bond strength data from an destructive degradation test on units that had been in service for different amounts of time. The data are used in SMRD2 Sections 20.4–20.5.

2. `AdhesiveBondB.csv`
   These data are from an accelerated destructive degradation test to estimate the failure-time distribution of an adhesive bond. The data were first given in Escobar, Meeker, Kugler, and Kramer (2003) and are used in SMRD2 Sections 20.4–24.9.

3. `AdhesiveFormulationK.csv`
   These data are from an accelerated destructive degradation test to estimate the failure-time distribution of an adhesive. The data were first given in Xie, King, Hong, and Yang (2018) and are used in SMRD2 Section 20.10.

4. `AlloyA.csv`
   This file contains data on fatigue crack length as a function of number of cycles. The data were obtained visually from Figure 4.5.2 in Bogdanoff and Kozin (1985, page 242). These data were analyzed in Lu and Meeker (1993) and are used in SMRD2 Example 1.10 and Sections 21.1–21.3.

5. `AlloyC.csv`
   These data are from an experiment to measure long transverse tensile strength (ksi) of a 7475-T651 aluminum plate (0.5–1.0 inch thick) and are used in SMRD2 Section 11.6.

6. `AlloyT7987.csv`
   This file contains fatigue lives of 67 specimens of Alloy T7987. There were also five specimens that were tested to 300 thousand cycles but that did not fail. These data are used in SMRD2 Sections 6.4, 11.6, and Exercise 11.17.

7. `ApplianceB.csv`
   This file contains use-rate accelerated test data presented in Meeker, Escobar, and Hong (2009) and used in SMRD2 Example 1.6 and Exercise 16.10.

8. `AutomaticTransmission.csv`
   This file contains automatic transmission recurrent events data given in Nelson (2003, Table 1.1) and used in SMRD2 Exercise 22.8.

9. `Backblaze.1Q2016.csv`
   This file contains Backblaze disk drive failure data as of 1Q2016 and used in Mittman, Lewis-Beck, and Meeker (2019).

10. `BackblazeDrive14.csv`
    Subset of `Backblaze.1Q2016.csv` containing drive model 14 and used in SMRD2 Section 23.1.

11. `BearingA.csv`
    These data are results of a small bench test of a roller bearing with three early failures (defective units). These data first appeared in Genschel and Meeker (2010) and are used in SMRD2 Example 8.17.

12. `BearingCage.csv`
    This file contains bearing-cage field-failure data consisting of fracture times for failed units and running times for units that have not failed. These data were abstracted from Abernethy, Breneman, Medlin, and Reinman (1983) and they are used in SMRD2 Example 8.18, Exercise 8.27, Section 10.2, Examples 10.8 and 10.9, and Section 15.7.

13. `Berkson10220.csv`
    This file contains interval-censored data for 10,220 times between Americium-241 $\boldsymbol{\alpha}$-particle arrivals. The data originally appeared in Berkson (1966). These data are used in SMRD2 Sections 7.1–7.6.

14. `Berkson200.csv`
    This file contains a random sample of size 200 from `Berkson10220.csv`. These data are used in SMRD2 Sections 7.1–7.6.

15. `BKfatigue10.csv`
    This file contains fatigue-failure data from Bogdanoff and Kozin (1985, pages 224–225) and they are used in SMRD2 Example 11.3.

16. `BleedSystem.csv`
    This file contains failure and running times for 2256 aircraft engine bleed systems. These data were abstracted from Abernethy et al. (1983) and are used in SMRD2 Example 6.5 and Exercise 8.20.

17. `BondStrength.csv`
    Failures in a microelectronic device were caused by weakened wire bonds. The data are from devices in three separate manufacturing batches and they are used in SMRD2 Exercise 12.13.

18. `BrakingGrids.csv`
    These are recurrent events data from two batches of locomotive braking grids, first presented in Doganaksoy and Nelson (1998) and used in SMRD Section 22.3.

19. `Bulb.csv`
    This file contains incandescent light bulb life-test data from Davis (1952) and used in SMRD2 Exercise 6.14.

20. `CeramicBearing02.csv`
    This file contains life test results on rolling contact fatigue of ceramic ball bearings given by McCool (1980) and are used in SMRD2 Exercise 17.3.

21. `ChainLink.csv`
    This file contains the results of a load-controlled high-cycle fatigue test conducted on chain links from Parida (1991) and used in SMRD2 Exercises 3.6, 6.8, and 8.3.

22. `CircuitPack04.csv`
    This file contains interval-censored field tracking data for circuit packs in a telecommunications system. The data were first reported by Hooper and Amster (1998, Table 9.1) and are used in SMRD2 Exercise 8.23.

23. `CircuitPack05.csv`
    This file contains data from a life test data conducted to compare the failure-time

distributions of circuit packs manufactured by two different vendors. The data were first reported by Hooper and Amster (1998, Table 9.2) and are used in SMRD2 Exercise 12.9.

24. `CircuitPack06.csv`
    This file contains data giving the number of failures observed during periodic inspections in a field trial of early production circuit packs and used in SMRD2 Examples 1.7, and 11.8.

25. `ComponentA.csv`
    This file contains data giving number of failures of a component type that is used numerous times in a large electronic system and are used in SMRD2 Exercises 7.4 and 8.6.

26. `ComponentB.csv`
    This file contains failure-free running times for early production metal components that had been introduced into service over time. The data are used in SMRD2 Example 8.17.

27. `CompTime.csv`
    This file contains the times to complete a computing task at a centralized computer service at Louisiana State University and used in SMRD2 Sections 17.1–17.3.

28. `ComputerLab.csv`
    This file contains computer lab maintenance recurrent events data used in SMRD2 Exercise 22.1.

29. `ConnectionStrength.csv`
    This file contains data on breaking strength of 20 wire connections given in Nelson (1982, page 348) and used in SMRD2 Exercise 16.6.

30. `ConnectorStress.csv` and `ConnectorStrength.csv`
    These files contain stress-Strength data from Liu and Abeyratne (2019, Section 6.2) and are used in SMRD2 Section 23.2.2.

31. `Cylinder.csv`
    This file contains locomotive engine cylinder replacement recurrent events data from Nelson and Doganaksoy (1989) and used in SMRD2 Section 22.2.3.

32. `DetonatorA.csv`
    This file contains shelf-life data for explosive detonators manufactured in 14 different batches. A component of the detonator was tested nondestructively and graded as pass or fail. The data are used in SMRD2 Exercise 12.11.

33. `DetonatorSensitivity.csv`
    This file contains test data to estimate a detonator's sensitivity (probability of detonating as a function of voltage) first reported in Dror and Steinberg (2008). These data are used in SMRD2 Exercise 8.28.

34. `DeviceA.csv`
    These data are from an accelerated life test data for an electronic device from Hooper and Amster (1998, Table 9.3) and used in SMRD2 Sections 18.3 and 18.4 and Exercises 18.7–18.9, 18.14, and 18.17.

35. `DeviceB.csv`
These data came from an accelerated repeated measured degradation test of a solid-state RF power amplifier and were first used in Meeker, Escobar, and Lu (1998). The data are used in SMRD2 Sections 21.5–21.6 and Exercise 21.19.

36. `DeviceC.csv`
These data are from am ALT of an integrated circuit device and are used in SMRD2 Exercise 18.3.

37. `DeviceG.csv`
These data are from a field-tracking study of an electro-mechanical subsystem that had two failure modes and are used in Sections 16.1, 16.3, 16.4, and 16.6 and in Exercises 16.2–16.4 in SMRD2.

38. `DeviceG.sim.pseudo.joint.independent.csv`
This file contains joint pseudo data derived from the DeviceG data under an independence assumption and is used in Section 16.6 in SMRD2.

39. `DeviceG.sim.pseudo.joint.dependent.csv`
This file contains joint pseudo data derived from the DeviceG data under a strong dependence assumption and is used in Section 16.6 in SMRD2.

40. `DeviceH.csv`
This file contains field-failure data for an electro-mechanical device that were first presented in Doganaksoy, Hahn, and Meeker (2000). They are used in Exercises 6.15 and 10.17 in SMRD2.

41. `DeviceJ40.csv`, `DeviceJ55.csv`, `DeviceJ69.csv`
These files contain field-failure data where a small proportion of units had failed at data-freeze dates 40, 55, and 69 months after introduction of units to the field. These data are used in Section 23.3 of SMRD2.

42. `DeviceN.csv`
This file contains current-status warranty-replacement data for a component in a larger product. The data are used in SMRD2 Exercises 8.25 and 15.15.

43. `DiskBer.csv`
These data come from an accelerated repeated measured degradation test to study block error rates (the ratio of number of bytes with errors to the total number of bytes tested) of magneto-optic data storage disks. The data first appeared in Murray (1993) and are used in SMRD2 Exercise 21.6.

44. `ElectronicSystem.csv`
This file contains failure data on devices in electronic systems that have been deployed in Earth orbit. The data are used in SMRD2 Exercise 3.8.

45. `Fan.csv`
This file contains diesel generator fan-failure data from Nelson (1982, page 133) and are used in SMRD2 Examples 1.3, 7.13, 11.2, and 11.19.

46. `GaAsLaser.csv`
This file contains data from a GaAs Laser accelerated repeated measures degradation test and are used in SMRD2 Example 20.2 and Exercise 21.24.

47. `HeaterComparison.csv`
    These data come from an accelerated life test comparing two suppliers of tubular heaters used in ovens and are used in SMRD2 Exercise 12.12.

48. `HeatExchanger.csv`
    These data are from nuclear power plant heat exchangers and are used in SMRD Examples 1.4, 3.2, 3.8, and Exercises 8.1, 8.2, 10.16.

49. `HypoidPinionGear.csv`
    These data come from an accelerated life test to estimate the relationship between fatigue life and torque and are used in SMRD2 Exercise 18.28.

50. `ICData.csv`
    This file contains the results of an accelerated life test, conducted at one level of elevated temperature, to study an electromigration-related failure mode. The data are used in SMRD2 Exercises 8.5 and 18.25.

51. `InkjetPenA.csv`
    These data are from a life test of an inkjet pen, comparing two different ink formulations and are used in SMRD2 Example 12.14.

52. `InkjetPrintheadB.csv`
    This file contains data from a life test of an inkjet printhead that resulted in two failure modes and is used in SMRD2 Exercise 16.9.

53. `InsulationBreakdown.csv`
    This file contains accelerated destructive degradation data first used in Nelson (2004, page 535) and used in SMRD2 Exercise 20.11.

54. `JEP118.csv`
    These interval-censored data come from an accelerated life test for an electronic device from Whitman (2003) and used as SMRD2 Exercise 19.1.

55. `KevlarWrappedPressureVessels.csv`
    This file contains accelerated life test data originally from Gerstle and Kunz (1983), but re-analyzed in many other places, including Section 23.4 of SMRD2.

56. `LaminatePanel.csv`
    This file contains data on the fatigue life to panel specimens tested at four different levels of stress that were analyzed in Shimokawa and Hamaguchi (1987) and Pascual and Meeker (1999). These data are analyzed in SMRD2 Section 17.6.

57. `LED.A.zero.start.csv`
    This file contains accelerated repeated measures degradation test data on an LED.

58. `LED.A.full.csv`
    The accelerated repeated measures degradation test data in this file were derived from `LED.A.zero.start.csv` by eliminating readings before 138 hours and renormalizing the data at 138 hours.

59. `LED.A.subset.csv`
    The repeated measures degradation test data in this file were derived from `LED.A.Life.csv` by excluding data from a different failure mode at 130°C and 40 mA.

60. `LEDLife.csv`
    This file contains pseudo failure times derived from the LED-A accelerated repeated measures degradation data in `LED.A.full.csv`. The data were first analyzed in Pascual, Meeker, and Escobar (2006) and also studied in SMRD2 Section 21.7.

61. `LEDLifeSubset.csv`
    These accelerated life-test data were derived from `LEDLife.csv` by excluding data from a different failure mode at 130°C and 40 mA.

62. `LFP1370.csv`
    These limited-failure-population data were first analyzed in Meeker (1987) and are used in SMRD2 Examples 1.2 and 3.7, Section 11.5, and Exercise 11.3.

63. `LZbearing.csv`
    These data from fatigue endurance tests were first given in Lieblein and Zelen (1956) and were analyzed in Lawless (1982) and SMRD1. The data are used in SMRD2 Section 3.4, Examples 1.1, 8.3, and 11.1, and Exercise 3.1.

64. `MachineH.csv`
    These recurrent events data are from preventive maintenance data on earth-moving machines and are studied in SMRD2 Example 22.5.

65. `MechanicalSwitch.csv`
    This file contains competing-risk failure-time data, with two failure modes, on mechanical switches are from Nair (1984) and are used in SMRD2 Exercise 16.8.

66. `MetalWear.csv`
    The data are from sliding-metal wear tests to study the wear resistance of a metal alloy and used in SMRD2 Example 11.1 and Exercises 21.13 and 21.15.

67. `MotorA.csv`
    This file contains field-failure data of a motor that is part of a larger system and is used in SMRD2 Exercises 11.6 and 15.15.

68. `Mylarpoly.csv`
    These data, given in Kalkanis and Rosso (1989), were from an accelerated life test of a Mylar-polyurethane insulating structure and are used in Section 18.5 and Exercises 18.22 and 18.23 in SMRD2.

69. `NewSpring.csv`
    These data were from a factorial accelerated test experiment to study the relationship between spring lifetimes and processing temperature, amount of displacement in the spring test (stroke), and processing method. The data were first used in Meeker, Escobar, and Zayac (2003) to illustrate a sensitivity analysis and is used in SMRD2 Section 19.3 and Exercise 19.17.

70. `NewTechnology.csv`
    These data are from a temperature-accelerated life test on an IC device and is presented or used in SMRD2 Section 19.1, Exercises 19.4, 19.6, and 19.7.

71. `NiCdBattery.csv`
    These accelerated test data on rechargeable nickel-cadmium battery cells were presented in Brown and Mains (1979) and used in SMRD2 Example 1.9 and Exercise 19.16.

72. `PartA.csv`
    These data data are from an experiment to compare three operators who performed life tests on a component in a cutting tool and are used in SMRD2 Example 12.2, Sections 12.2 and 12.5, and Exercises 12.7 and 12.8.

73. `PhotoDetector.csv`
    These data, reported by Weis, Caldararu, Snyder, and Croitoru (1986), were from a life test on silicon photodiode detectors and used in SMRD2 Exercises 3.12 and 6.9.

74. `ProductE.csv`
    The data were derived from warranty returns of a product subjected to 19 different failure modes and are used in SMRD2 Sections 16.4 and 16.5 and Exercises 16.5, 16.17, 16.18, and 16.19.

75. `PrintedCircuitBoard.csv`
    The data, given in Meeker and LuValle (1995), were from humidity-accelerated life test of printed circuit boards and are used in SMRD2 Example 1.8 and Exercise 1.11.

76. `Resistor.csv`
    These data, given in Suzuki, Maki, and Yokogawa (1993), were from a temperature-accelerated repeated-measures degradation test of carbon-film resistors and are used in SMRD2 Exercise 21.12.

77. `RocketMotor.csv`
    The data were from a field-performance assessment of rocket motors, installed in missiles, that failed due to thermal cycling. The data were given in Olwell and Sorell (2001) and used in SMRD2 Section 10.5.

78. `ShockAbsorber.csv`
    This file contains failure times (in kilometers driven) of vehicle shock absorbers and were reported in O'Connor (1985). The data are used in SMRD2 Sections 8.2, 8.3, 9.3, and 9.4, Examples 3.10, 3.11, 3.12, 6.2, 8.1, 8.2, 9.10, and 9.11 and Exercise 8.13

79. `Snubber.csv`
    These data, first given in Nelson (1981), were obtained from an accelerated test comparing two toaster snubber designs. The data are used in SMRD2 Examples 12.1, 12.3, 12.5, 12.6, 12.7, 12.8, 12.9, and 12.10 and Exercises 12.3, 12.4, and 12.5.

80. `SuperAlloy.csv`
    The data set, given in Nelson (1984) and Nelson (2004), contains fatigue life-test results from a strain-controlled test of a nickel-base superalloy. The data are used in Examples 17.7, 17.8, 17.9, and 17.10 and Exercises 17.9 and 17.12.

81. `SystemE.csv`
    This file contains recurrent events data from an electronic system with three different event types. The data are used in SMRD2 Exercises 22.8 and 22.9.

82. `Tantalum.csv`
These data, from Singpurwalla, Castellino, and Goldschen (1975), resulted from a temperature- and voltage-accelerated life test of tantalum capacitors and are used in SMRD2 Exercise 19.15.

83. `TireDataSet.csv`
These data, given in Krivtsov, Tananko, and Davis (2002), were from an experiment that was designed to reproduce automobile tire failures that had been seen in the field. They are use in SMRD2 Exercise 17.5.

84. `Titanium01.csv`
The data were obtained from a fatigue test of titanium alloy specimens and are used in SMRD2 Exercise 6.7.

85. `Transistor.csv`
These data, given in Wilk, Gnanadesikan, and Huyett (1962), were from an accelerated test of transistors and are used in SMRD2 Exercise 6.5.

86. `TurbineDevice.csv`
These data were from a life test of a newly designed turbine device and are used in SMRD2 Exercise 16.7.

87. `TurbineWheel.csv`
Nelson (1982) presented these current status data from a study to estimate the time-to-crack initiation in turbine wheels. They are used in SMRD2 Examples 1.5, 3.14, and 6.4 and Exercise 1.9.

88. `ValveSeat.csv`
These recurrent events data on the replacement of locomotive engine valve seats first appeared in Nelson (1995, 2003). They are used in SMRD2 Examples 22.1 and 22.2 and given in Table D.7.

89. `WorkStation.csv`
This file contains recurrent events data giving computer work station trouble reports. SMRD2, Exercise 16.1

90. `ZelenCap.csv`
The data were from a factorial experiment to study the effect of voltage and temperature on capacitor lifetime. The data were first analyzed in Zelen (1959) and used in SMRD2 Examples 17.15 and 17.16 and Exercises 17.16 and 17.20.

91. `ZelenCapSub.csv`
These data are a subset of `ZelenCap.csv` with the bad data at 180C and 200 volts removed. They are used in SMRD2 Example 17.17.

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