APPENDIX B. DETERMINING MEF USING A TEST PROCEDURE SPREADSHEET PROGRAM

TABLE OF CONTENTS

B.1 INTRODUCTION B-1

B.2 BACKGROUND B-1

B.3 INSTRUCTIONS FOR TEST PROCEDURE SPREADSHEET [*Compact_MEF_value.xls*] B-2

B.4 DEFINITIONS B-3

B.5 SAMPLE RESULTS FOR DETERMINING MEF VALUES B-4

LIST OF TABLES

Table B.1 Input Parameter Assumptions for Estimating MEFs from Energy Factors B-4
Table B.2 Estimated MEF Values for 1.56 and 1.96 Cubic Foot Clothes Washers B-5

APPENDIX B: DETERMINING MEF USING A TEST PROCEDURE SPREADSHEET PROGRAM

B.1 INTRODUCTION

The current metric to measure clothes washer efficiency, EF cannot be directly converted to the future metric, MEF. This is due to differences in the current and future DOE test procedures for clothes washers, Appendix J(current) and Appendix J1 (future). However, when both test procedures are modeled in a spreadsheet, we can calculate what the EF and MEF would be for the same set of input parameters. The primary difference between EF and MEF is that the MEF includes a dryer energy use. The dryer energy is based on the remaining moisture content (RMC) of the test cloth in the dryer after the final spin cycle.

B.2 BACKGROUND

The Department of Energy (DOE) clothes washer test procedure (Appendix J) was updated in order to more accurately reflect actual energy usage and adapt to the continuing changes in clothes washer design. This updated test procedure was published in the *Federal Register* on August 27, 1997 and became effective on February 23, 1998. In addition, a new updated test procedure (often referred to as Appendix J1) will take effect only when the proposed clothes washer standard is enacted.

Old Appendix J test procedure.

This test procedure specifies 140° F inlet water, and 416 cycles per year. This test procedure did not specify an actual cloth test load for vertical axis clothes washers. For this and other reasons this test procedure would not reflect realistic energy savings due to adaptive control or auto-fill features.

New Appendix J test procedure.

The interim (new Appendix J) test procedure will not alter the energy factor of any existing clothes washer that minimally comply with the existing efficiency standard. Test procedure changes include (1) using 392 cycles per year, (2) clarification of wash/rinse temperatures to avoid ambiguity, (3) specification of agitation and spin speed settings, and (4) new provisions to account for an automatic fill control feature. In addition, the following informational measures will be defined: total (both hot and cold) water consumption, remaining moisture content (RMC) in a test load after the final spin cycle, and a calculated modified energy factor (MEF). The MEF will include the energy needed to dry clothes in a dryer after a final washer spin cycle.

Appendix J1 test procedure.

This test procedure will make some of the informational changes in the new "Appendix J" test procedure mandatory. Major changes in the test procedure preclude making adjustments from the existing test procedure with only a correction factor. Among the changes in test procedure will be (1) new temperature use factors (TUF's), (2) lowering inlet hot water from

140° F to 135° F, and (3) provisions to account for adaptive control and auto-fill. (Temperature use factors are used to prorate energy consumption among cold, warm and hot wash, as well as to factor in a warm rinse if offered.) Clothes washer loads specified will depend on washer clothes container volume. Remaining moisture content after a final spin cycle will be accounted for and a modified energy factor (MEF) will replace the current energy factor (EF). The above changes should result in a more accurate prediction of actual energy.

B.3 INSTRUCTIONS FOR TEST PROCEDURE SPREADSHEET [*Compact_MEF_value.xls*]

Both DOE test procedures J and J1 have been modeled on an Excel spreadsheet. The input parameters are entered into both J and J1. In some cases, these parameters are the same, such as the capacity of the washer basket. In other cases, additional information is required for the J1 test procedure. Inputs can be adjusted to produce a desired EF. The same inputs are then used to calculate an MEF based on the calculations for the J1 test procedure.

The test procedure model [*Compact_MEF_value.xls*] consists of four Excel worksheets: *App_J, App_ J1, Comparison and Tub.*

- *App_J* includes all of the equations of the current test procedure
- *App_J1* includes all of the equations in the J1 test procedure
- *Comparison* contains the input table and allows the user to change input assumptions. Some of these assumptions are in terms of ratios that can be based on rules of thumb based on existing washers.
- *Tub* is used to estimate the gallons of water use per fill if this value is not known from other sources.

Step 1: Determine water use from basket capacity (Tub capacity spreadsheet)

If the maximum water fill capacity of a washer is not known or if a generic example is being created follow the procedure below. A tub capacity spreadsheet can assist with this exercise.

Enter:
a) basket capacity
b) estimate the water fill fraction
c) estimate the basket diameter
d) estimate the annulus gap

From this we can calculate:
a) basket height
b) tub diameter
c) water height
d) gallons to fill the basket

e) gallons to fill the annulus
f) total maximum fill gallons

Step 2: Enter other parameters into test procedure spreadsheet [spreadsheet: *Compact_MEF_value.xls*]

Inputs
Enter into ***Comparison Sheet***

- Washer Drum Capacity
- Mechanical Energy
- Max. test cloth load
- RMC max. extraction
- RMC min. extraction
- Max. Fill capacity
- Ratio of Min. fill / Max. fill
- Fraction Hot in Warm
- Percent wash water
- Percent rinse water
- Values for warm rinse if washer has a warm rinse option
- Whether or not the washer has a adaptive fill and what the ratio is for adaptive fill gallons to maximum fill gallons.
- Rinse / Wash ratio

B.4 DEFINITIONS

- *Washer Drum Capacity* is the volume in the washer basket as determined by the test procedure.

- *Max. Test Cloth Load* is the load as specified in Table 5.1 of Appendix J1 of the clothes washer test procedure. For V-axis washers, Appendix J doesn't require a test load if it is not adaptive fill.

- *Mechanical Energy* is the energy used by the washer motor.

- *RMC max. extraction* is the remaining moisture content after final spin.

- *RMC min. extraction* is lower remaining moisture content if multiple spins are available (see test procedure for details).

- *Ratio of: Min. fill / Max. fill* – minimum fill is the gallons of water when the washer fill setting is at its minimum setting; maximum fill is the gallons of water when the washer is set at its maximum water fill setting.

- *Fraction hot in warm* is the fraction of hot water mixed with cold water to achieve the warm water inlet temperature. For example, a 0.4 fraction means warm water is achieved by mixing 40% hot water with 60% cold water.

- *Percent wash water* is the percentage of the total water use that is used in the wash cycle.

- *Percent rinse water* is the percentage of the total water use that is used in the rinse cycle.

- *Adaptive Fill Ratio* is the gallons of fill is adaptive fill control were used divided by the max. fill.

- *Rinse / wash ratio* is the gallons of rinse water used per gallon of wash water. For example, R/W = 1 assumes that this ratio is constant for Max. and Min. fill levels.

B.5 SAMPLE RESULTS FOR DETERMINING MEF VALUES

Based on the assumptions in Table B.1, MEF values were estimated for clothes washer capacities of 1.56 and 1.96 cubic feet. An additional assumption assumes the washer does not have an adaptive fill control.

Table B.1 Input Parameter Assumptions for Estimating MEFs from Energy Factors

INPUT PARAMETER	Value	Value
Basket Capacity (cu. ft.)	1.59	1.96
Mechanical Energy (kwh/cycle)	0.27	0.27
RMC max. extraction	0.72	0.72
RMC min. extraction	0.72	0.72
Ratio of Min. fill / Max. fill	0.5	0.5
Fraction hot in warm	0.5	0.5
(Rinse / Wash) Ratio	1.0	1.0

Based on the above assumptions, Table B.2 shows the MEF values were estimated for a 1.59 cu.ft. and a 1.96 cu. ft. capacity clothes washers. In addition to the above assumptions, a maximum water fill was required. This value was selected based on what level EF it would produce. The EF was based on an assumed Alt. II and Alt. III temperature use factor (TUF) configurations from Appendix J (both give the same result). The Energy Factors used were based on the following:

- 0.90 current minimum EF for top-loading compact washers (compact means <1.6 cu.ft.)
- 0.99 EF of an existing model washer with a 1.59 cu. ft. capacity
- 1.18 current minimum EF for standard capacity washers
- 1.20 EF of an existing model washer with a 1.96 cu. ft. capacity
- 1.32 EF of an existing model washer with a 1.96 cu. ft. capacity

Table B.2 Estimated MEF Values for 1.56 and 1.96 Cubic Foot Clothes Washers

Basket Capacity Cu. Ft.	EF (Energy Factor)*	Max. Gallons Fill	Estimated MEF	
			No warm rinse	With warm rinse
1.59	0.90	15.0	0.75	0.65
	0.99	13.3	0.79	0.69
1.96	0.90	19.0	0.76	0.66
	1.18	13.9	0.86	0.76
	1.20	13.6	0.86	0.77
	1.32	12.1	0.90	0.81

* Assuming a Alt. II or Alt. III cycle configuration