

***Procedures for calibrating AS - 9 swatch batches
for use in determining reference batch equivalent
percentage soil removal values when testing to
AS/NZS 2040.1***

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Background

At present, energy performance testing of clothes washers in Australia and New Zealand is conducted in accordance with AS/NZS 2040.1:2005. This standard includes provision for determining the percentage soil removal of a washer which constitutes a minimum performance standard in the Australian/New Zealand regulatory scheme.

Measurement of soil removal performance relies upon the use of soiled swatches known as AS-9 swatch as currently supplied by Centre for Test Materials in the Netherlands. This material is produced in batches on rolls of cotton base cloth. Experience over the past 15 years has shown that the production process presents 2 main issues:

1. On occasion a batch is produced whereby there is significant variation in the washability of the material depending upon which section of the batch is selected for use.
2. Subtle variations in the processes and materials used to produce each batch mean that the washability of the swatches varies from batch to batch. This variation can be significant and testing of historical batches has shown variations in soil removal results of 10 percentage points or more.

Issue 1 is simply a quality control issue that requires occasional rejection of a batch if it cannot be demonstrated to have a minimum level of consistency across the batch. Issue 2 is a consequence of the production process and cannot be avoided, however such variations from batch to batch can be normalised provided the washability of each batch is determined against a given standard (or reference batch). To this end AS/NZS 2040.1 notes as follows:

15 NORMALIZATION OF RESULTS

When the percentage soil removal for each swatch has been calculated the value shall be converted into a reference batch equivalent percentage soil removal value. This shall be performed using a graph or formula obtained from <http://www.energyrating.gov.au> website for the particular soiled swatch batch used for the test.

All values of average soil removal and standard deviation reported in accordance with this Standard shall be calculated from the reference batch equivalent (i.e. normalized) values.

The remainder of this document details the procedures for testing a swatch batch to determine:

- That it meets the validation criteria for consistency across the batch. This is measured for both the unwashed and the washed states.
- The normalisation formula (curve) for converting soil removal results obtained for the batch under test into a reference batch equivalent percentage soil removal

Overview of the calibration procedure

The swatch manufacturer prepares a swatch batch then takes samples of that batch for testing. These samples are forwarded to the testing laboratory. The test laboratory then undertakes a soil removal test procedure on the sample swatches generally in accordance with AS/NZS 2040.1 except as noted otherwise in this document.

In summary the procedure is as follows:

1. Each swatch to be tested is marked with a unique identifier that can be cross referenced to determine the batch it has come from as well as its position in the roll.
2. The test laboratory pre measures the reflectance of each swatch in the sample to determine if the unwashed sample meets the verification criteria for consistency of the unwashed swatches. If it meets the criteria the testing can proceed, if not the batch is rejected
3. The test laboratory then selects designated swatches from the delivered samples and attaches those swatches to the wash load. In addition, the test laboratory also attaches a number of samples from a “verification swatch batch”¹ to the wash load. The verification swatch batch is selected to give a known wash performance (within certain tolerances) during the calibration procedure. Failure to achieve the expected wash performance for the verification swatch batch is an indication that the wash process is likely to have been in some way compromised and the test is invalidated. A re test may be undertaken.
4. The wash load along with the swatch samples is then loaded into a Wascator reference machine and washed on a specified program using a set quantity and type of detergent.
5. At the end of the program the load is removed, the swatches detached, dried, ironed and measured to determine % soil removal as per the requirements of AS/NZS 2040.1.
6. This process (3-5) is undertaken 3 times, each time a different wash program is used. Each of the 3 programs used are designed to produce different levels of soil removal
7. The results are then evaluated to determine:
 - If the test was valid
 - If the batch meets the consistency verification criteria
 - What the appropriate normalisation formula (curve) is for the batch

Swatch Sampling Procedures

Sampling Method

A minimum of 3 one metre transverse sections must be cut from any roll to be calibrated. Samples must be taken at the start and end of the roll and also at a maximum 40 metre intervals along the length of the roll. Figure 1 below shows how a 200 metre roll should be sampled.

¹ Note: The “verification swatch batch” was formerly referred to as the “reference batch”

Table 1: Test Procedure specifications

Parameter	Specification
Test Machine	Wascator FOM 71 CLS
Detergent Type	IEC type B
Detergent Quantity	See program details below
Perborate Quantity	0 g
Detergent Delivery	Dry via the dispenser
Anti Foam agent	Anti-sudsing agent LN1414
Anti Foam quantity	5 g
Test Load Type	Nylon makeweights (26 cm x 28 cm nylon rectangle)
Test Load makeup	80 makeweights
No. of swatches per run	30 in total for a 200m roll 4 samples from 6 locations plus 6 samples from the “verification swatch batch”
Wash Programs	3 No. to be run Short, Medium, Long See Table 2 below
Water flow rate	Approx. 10 litres / minute
Spectrophotomic measurement specifications	Instrument – as specified in AS/NZS 2040.1 Aperture Diameter = 20mm min Tristimulus = Y Observer = 10° Illuminant = D65 Geometry = 0/45 or D8 Specular - excluded
Pre-conditioning of the makeweights	Pre Conditioning of Makeweights is required for any new makeweights, a total of 10 pre-conditioning runs shall be carried out
Cleaning the makeweights	Following each test run , run the makeweights through a rinse program (main wash + 2 rinses) on a machine other than the reference machine. Set the makeweights to dry to ambient humidity before re-using.
Cleaning the reference machine	Before the first test and then after every 3 runs of the reference machine conduct a cleaning run. The cleaning run shall use a hot wash and detergent. The cleaning run shall be carried out without any load. Between each run conduct a warm 40°C run without detergent and without any load
Parameters to be recorded during the test	<ul style="list-style-type: none"> • Detergent batch • Elapsed time of test • Water volume • Electrical Energy consumption • Final spun mass of the makeweights • Cold and hot water fill flowrate

Table 2: Wash program specification (see appendix A for detailed programming)

Program ID		AS9-5	AS9-10	AS9-20
Run Number ID for analysis spreadsheet		2	3	4
Program Name		Short (5)	Medium (10)	Long (20)
Wash (hot & cold fill)	Volume (L)	30	30	30
	Time (s)	270 ¹	540 ¹	1200 ¹
	Temp (C)	40 ²	40 ²	40 ²
	Action / rpm	normal / 52	normal / 52	normal / 52
	Detergent dose (g)	35.0	35.0	35.0
	Antifoam dose (g)	5.0	5.0	5.0
Spin 1	Time (s)	60	60	60
	rpm	1100	1100	1100
Rinse (cold only fill)	Volume (L)	15	15	15
	Temp (C)	20	20	20
	Time (s)	180	180	180
	Action / rpm	normal / 52	normal / 52	normal / 52
Spin 2	Time (s)	60	60	60
	rpm	1100	1100	1100

Note 1: The machine is set to start counting down the wash time as soon as the fill is complete (the default is to start the countdown from the first moment 40 C is established and this can vary slightly from wash to wash and so affect the overall wash time - this is a hardware change and can't be done through the software.

Note 2: The target wash temperature is set at 40 + 0/- 2 C - this is to stop the hot supply shutting off if the machine measures a temp in excess of 40 C during the fill

Data processing

A spreadsheet is provided to automate the data processing of the results.

Test results are input into the "Input Data" sheet in 2 parts:

- Base cloth readings
- Sample Swatch readings

Base cloth Measurements

The following data shall be recorded (fields in red are optional) for 16 samples of the base cloth. The results shall be input into fields X12 to AM27 (highlighted in blue) of the input data tab.

Measurement ID

Product ID

Extra ID

Date

X 10\D65
 Y 10\D65
 Z 10\D65
 X 2\D65
 Y 2\D65
 Z 2\D65
 X 2\A
 Y 2\A
 Z 2\A
 X 10\A
 Y 10\A
 Z 10\A

Sample Swatch Readings

The table below details the type and format required for each swatch reading undertaken in the calibration process. Details of the particular input requirements into each column can be found immediately below the sample input table.

The data is input into fields B12 to H500 (highlighted in blue) of the input data tab. There is one line for each swatch including the verification swatches. For the 3 test runs on a typical 200 metre roll there would normally be 90 readings (ie 90 lines of data)

Table 3: Example of sample swatch reading data input format

Batch No:	55					
Run	Transverse Strip	Longitudinal strip	Swatch No	Y Initial	Y Final	%SR
3	1	1	1001	42.29	66.97	80.18339
3	1	2	1002	42.7	68.25	81.6981
3	1	3	1003	43.14	68.33	81.34031
3	1	4	1004	43.4	68.54	81.37839

Batch No: – This is the nominated batch number as detailed by CFT

Run - Each run using a differing program is assigned a number. The 3 runs used to undertake the 3 different wash programs are detailed in Table 2. These are numbered as Run 2 (Short), Run 3 (Medium) and Run 4 (Long). Run numbers 1 and 5 are reserved for extra short and extra long runs respectively that may be undertaken

Transverse strip – This indicates the section of the roll (along its length) from where the sample was taken. Transverse strips from the batch under test are numbered from left to right starting at 1. A 200m roll typically has 6 transverse strips (numbered 1 to 6 inclusive). Swatches from the verification swatch batch are designated as Transverse strip 0

Longitudinal Strip The width of the roll is divided up into strips from which the swatches are cut. The longitudinal strips from the batch under test are numbered from top to bottom starting at 1 ie if a total of 4 strips are used then the numbering will be 1,2,3 and 4

Swatch number – This is optional to complete and is simply a reference number marked on the swatch as used by the laboratory to identify the particular swatch.

Y initial – This is the initial reflectance reading for the unwashed swatch

Y Final - This is the final reflectance reading for the washed swatch

% SR – This is the soil removal result as calculated from the washed and unwashed readings using the method as noted in AS/NZS 2040.1

Acceptance Criteria

The acceptance criteria for part or all of a batch is set out in the “check” tab of the spreadsheet (follow the steps).

In summary the checks to perform are as follows:

1. Check that the initial unwashed swatch readings (excluding the verification swatch samples) are within acceptable limits of consistency. The acceptable range across the entire set of unwashed samples is 3 percentage points.
2. Check that the verification swatch results are within the limits of acceptability. The acceptable range is as follows:
 - Short Wash: ± 2.5 percentage points of the target
 - Medium Wash: ± 2 percentage points of the target
 - Long Wash: ± 2 percentage points of the target

For the current verification swatch batch (28) the target soil removal results are:

- Short Wash: 70.88
- Medium Wash: 76.43
- Long Wash: 81.04

3. Check which sections of the batch if any meet the acceptance criteria for consistency. Averaged results across each longitudinal section and each transverse section of a batch must meet the acceptance criteria if that section is to be approved. Variation across any set of longitudinal or transverse sections of the batch (averaged) must not exceed 2 percentage points for the medium or long wash programs or 3 percentage points for the short wash program. Part sections of the batch may be approved but only the approved parts may be included in the calculation of the calibration curve. For the purposes of approval, a part section must include at least 3 contiguous transverse sections and 2 contiguous longitudinal sections or 2 contiguous transverse sections and 3 contiguous longitudinal sections.

Calculating the Calibration curve

The calibration curve for a batch is described by a curve with the form:

$$a * SR + b * SR^2$$

where:

SR = the measured soil removal

a = a constant

b = a constant

The constants a and b are determined for 2 cases, one to suit the use of top load detergent and one to suit the use of IEC type B detergent.

The values of the constants a and b are calculated by the analysis spreadsheet by using the following procedure:

- Open the tab entitled “Calibration”
- At the top of the page in the cells C8 to H15 select which sections of the batch have been accepted (ie based on the results from step 4 in the “checks” tab)
- The calibration curve specifications are calculated in the yellow cells (B53 to D57). Press Ctrl Q until both cells E56 and E57 note “Curve Fit OK” then press Ctrl Q twice more (the values for a and b should remain unchanged)

Once the calibration process is completed the “output” file is ready to send to the program manager for integration into the published swatch calibration data sheets available at <http://www.energyrating.gov.au/pubs/swatchnormalisationcalculator.xls>

Verification Swatch batch

As noted the calibration process utilizes a “verification swatch batch”. At present this is batch number 28 and as of June 2010 there were approximately 380 samples of this batch available for use. Should the reserves of this reference batch drop below 300 samples, a new verification swatch batch must be identified from existing stocks held by CFT. Verification swatch batches are typically chosen from batches with low variability across the batch (<1.0% is preferred).

The new target soil removal results for any new verification swatch batch are determined by undertaking test runs at each of the 3 wash durations using only swatches from the current verification batch and the proposed new verification batch. Provided the results for the current batch meet the validity criteria then the results for the proposed new verification batch can then be used as target soil removal results for the new batch.

At least 3 valid repeat runs should be undertaken at each of the wash durations and the results averaged. Once a new verification swatch batch has been identified a minimum of 1000 samples should be reserved for future test runs.

Once new target soil removal results have been determined these must be input into the analysis spreadsheet in the “Checks” tab in cells B28 to B30.

Appendix A

Programs for use in Reference Machine (Wascator FOM 71CLS)

AS9-5-SHORT

Size 134/1240 Bytes (11%)
 Machine FOM71CLS
 Modules 8

0	Head	
	Motor Gentle Action On Time	00:03
	Motor Gentle Action Off Time	00:12
	Motor Normal Action On Time	00:12
	Motor Normal Action Off Time	00:03
1	Mainwash(1)	
	Wash Time In Min:Sec	04:30
	Temperature	40°C
	Temperature Hystereses	4°C
	First Fill Level	30
	Level Hystereses	25
	Cold Water	On
	Hot Water	On
	Heat Motor Action Normal	On
	Wash Motor Action Normal	On
	Motor Speed During Filling (Rpm)	30
	Motor Speed During Heating (Rpm)	52
	Motor Speed During Wash (Rpm)	52
	Motor Acceleration (Rpm/sec)	25
	Detergent Compartment 2	Level no refill
2	Drain(1)	
	Motor N	On
	Drain Normal	On
	Drain Time (min:sec)	00:40
	Motor Speed During Drain Time (Rpm)	52
	Motor Acceleration During Drain (Rpm/sec)	25
3	Spin(1)	
	Drain Normal	On
	Extract Time (Min:Sec)	01:00
	Extract Speed in Rpm	1100
4	Rinse(1)	
	Wash Time In Min:Sec	03:00
	Temperature	0°C
	Temperature Hystereses	4°C
	First Fill Level	15
	Level Hystereses	25
	Cold Water	On
	Heat Motor Action Normal	On
	Wash Motor Action Normal	On
	Motor Speed During Filling (Rpm)	30
	Motor Speed During Heating (Rpm)	52
	Motor Speed During Wash (Rpm)	52
	Motor Acceleration (Rpm/sec)	25
	Detergent Compartment 2	Level no refill
5	Drain(2)	
	Motor N	On
	Drain Normal	On
	Drain Time (min:sec)	00:40
	Motor Speed During Drain Time (Rpm)	52
	Motor Acceleration During Drain (Rpm/sec)	25
6	Spin(2)	
	Drain Normal	On
	Extract Time (Min:Sec)	01:00
	Extract Speed in Rpm	1100
7	End	

AS9-10-MEDIUM

Size 134/1240 Bytes (11%)
 Machine FOM71CLS
 Modules 8

0	Head	
	Motor Gentle Action On Time	00:03
	Motor Gentle Action Off Time	00:12
	Motor Normal Action On Time	00:12
	Motor Normal Action Off Time	00:03
1	Mainwash(1)	
	Wash Time In Min:Sec	09:00
	Temperature	40°C
	Temperature Hystereses	4°C
	First Fill Level	30
	Level Hystereses	25
	Cold Water	On
	Hot Water	On
	Heat Motor Action Normal	On
	Wash Motor Action Normal	On
	Motor Speed During Filling (Rpm)	30
	Motor Speed During Heating (Rpm)	52
	Motor Speed During Wash (Rpm)	52
	Motor Acceleration (Rpm/sec)	25
	Detergent Compartment 2	Level no refill
2	Drain(1)	
	Motor N	On
	Drain Normal	On
	Drain Time (min:sec)	00:40
	Motor Speed During Drain Time (Rpm)	52
	Motor Acceleration During Drain (Rpm/sec)	25
3	Spin(1)	
	Drain Normal	On
	Extract Time (Min:Sec)	01:00
	Extract Speed in Rpm	1100
4	Rinse(1)	
	Wash Time In Min:Sec	03:00
	Temperature	0°C
	Temperature Hystereses	4°C
	First Fill Level	15
	Level Hystereses	25
	Cold Water	On
	Heat Motor Action Normal	On
	Wash Motor Action Normal	On
	Motor Speed During Filling (Rpm)	30
	Motor Speed During Heating (Rpm)	52
	Motor Speed During Wash (Rpm)	52
	Motor Acceleration (Rpm/sec)	25
	Detergent Compartment 2	Level no refill
5	Drain(2)	
	Motor N	On
	Drain Normal	On
	Drain Time (min:sec)	00:40
	Motor Speed During Drain Time (Rpm)	52
	Motor Acceleration During Drain (Rpm/sec)	25
6	Spin(2)	
	Drain Normal	On
	Extract Time (Min:Sec)	01:00
	Extract Speed in Rpm	1100
7	End	

AS9-20-LONG

Size 132/1240 Bytes (11%)
 Machine FOM71CLS
 Modules 8

0	Head	
	Motor Gentle Action On Time	00:03
	Motor Gentle Action Off Time	00:12
	Motor Normal Action On Time	00:12
	Motor Normal Action Off Time	00:03
1	Mainwash(1)	
	Wash Time In Min:Sec	20:00
	Temperature	40°C
	Temperature Hystereses	4°C
	First Fill Level	30
	Level Hystereses	25
	Cold Water	On
	Hot Water	On
	Heat Motor Action Normal	On
	Wash Motor Action Normal	On
	Motor Speed During Filling (Rpm)	30
	Motor Speed During Heating (Rpm)	52
	Motor Speed During Wash (Rpm)	52
	Motor Acceleration (Rpm/sec)	25
	Detergent Compartment 2	Level no refill
2	Drain(1)	
	Motor N	On
	Drain Normal	On
	Drain Time (min:sec)	00:40
	Motor Speed During Drain Time (Rpm)	52
	Motor Acceleration During Drain (Rpm/sec)	25
3	Spin(1)	
	Drain Normal	On
	Extract Time (Min:Sec)	01:00
	Extract Speed in Rpm	1100
4	Rinse(1)	
	Wash Time In Min:Sec	03:00
	Temperature	0°C
	Temperature Hystereses	4°C
	First Fill Level	15
	Level Hystereses	25
	Cold Water	On
	Heat Motor Action Normal	On
	Wash Motor Action Normal	On
	Motor Speed During Filling (Rpm)	30
	Motor Speed During Heating (Rpm)	52
	Motor Speed During Wash (Rpm)	52
	Motor Acceleration (Rpm/sec)	25
	Detergent Compartment 2	Level no refill
5	Drain(2)	
	Motor N	On
	Drain Normal	On
	Drain Time (min:sec)	00:40
	Motor Speed During Drain Time (Rpm)	52
	Motor Acceleration During Drain (Rpm/sec)	25
6	Spin(2)	
	Drain Normal	On
	Extract Time (Min:Sec)	01:00
	Extract Speed in Rpm	1100
7	End	