



September 2006

Report for:
Standards Committee
EL 15-4

Development of a Global Standard for the Testing of Clothes Washers

Stage 1 - Load and Detergent



FOREWORD

This report was prepared by Energy Efficient Strategies under contract to The Equipment Energy Efficiency committee (E3). Contributions to the report were also made by Test Research.

Further information is available from Mr Robert Foster of Energy Efficient Strategies.

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ABBREVIATIONS

E3	Equipment Energy Efficiency Committee
AGO	Australian Greenhouse Office
EES	Energy Efficient Strategies P/L



1. Introduction

On the 5th August 2005, EL 15-4 Working Group No. 9 was formed with a task to investigate options for moving towards a more international approach to the testing of clothes washers intended for sale in the Australian and New Zealand markets.

That working group subsequently made the following recommendations to the EL 15-4 Standards committee:

- That EL 15-4 actively work towards the adoption of a global standard.
- The global standard to be adopted should be IEC 60456 Edition 6 which is expected to be available sometime after 2011.

The working group recommended that the adoption of a global standard should be a staged approach and that the first stage should cover two aspects:

- Investigate the adoption of the current IEC load for use in the current Australian/New Zealand Standard. The recommendation was that initially the IEC load could be provided as an alternative to using the AS/NZS load and eventually it would replace the AS/NZS load.
- As a preparatory step in moving toward the use of a “global detergent” investigations be undertaken into the possible adoption of a single detergent for use in the AS/NZS standard and that that detergent should be the detergent currently used for drum type machines ie IEC Type B detergent.

This report details the outcomes from those investigations. In particular this report details the measured impacts on the full range of performance measures including wash, rinse, severity of wash, water extraction and energy and water consumption.

1.1 Objective of the Study

This testing program is intended to provide comparative performance results for both top load (vertical axis) (4 test samples) and front load (horizontal axis) (2 test samples) clothes washers using firstly the current AS/NZS clothes load then the IEC clothes load specified in IEC60456.

In addition, the program was to provide comparative performance results for top loaders using firstly the current AS/NZS non drum detergent followed by the current AS/NZS drum type detergent (IEC type B). These comparative tests for detergents were conducted using the IEC load.

These results of this study are to be used by the EL 15/4 standards committee to help inform their decision regarding a proposed eventual shift to the exclusive use of the IEC load and the IEC type B detergent for performance testing to AS/NZS 2040.1



1.2 What was Tested ?

A total of 6 clothes washers were used for the comparative tests. The range included medium and large capacity models of top load agitators, top load impellers and drum type front loaders. The test units were as follows:

- 1 No. 5.5 kg Agitator type top loader
- 1 No. 8.0 kg Agitator type top loader
- 1 No. 5.5 kg Impeller type top loader
- 1 No. 8.0 kg Impeller type top loader
- 1 No. 5.5 kg front loader
- 1 No. 8.0 kg front loader

Tests were conducted in 3 stages as follows:

Stage 1 – Repeatability testing under current AS/NZS Standard conditions (12 runs total) – 2 runs on each machine. Results for these tests are reported in Section 3.

Stage 2 – Comparative testing of IEC load (12 runs in total) – 2 runs on each machine. Results for these tests are reported in Section 3.

Stage 3 – Comparative testing of IEC type B detergent in top loader machines (8 runs in total) – 2 runs on each machine. Results for these tests are reported in Section 4.

In each set of tests the following parameters were measured:

- cold water used [L]
- hot water used [L]
- total water used (including water to dissolve detergent) and PBIS [L]
- electrical energy [kWh]
- cold water energy correction [kWh]
- hot water energy [kWh]
- total energy [kWh]
- PAEC
- Program time [min]
- wet mass [kg]
- Water Extraction Index (WEI)
- normalized average soil removal
- Standard Deviation (SD)
- SR - 2 x SD
- severity of washing action index
- Rinse performance - water supply [mg/L]
- Rinse performance - conditioned load liquor [mg/L]
- Rinse performance - rinse liquor [mg/L]
- Rinse performance score [mg/kg of load]

Further Testing details are included in Appendix A. The project specification and details of the methods for swatch fixing and loading of IEC loads are included in Appendix B.



2. Key Project Findings & Recommendations

The findings noted below are drawn from the detailed analysis contained in sections 3 and 4. For details of the reasoning which underpins these findings, please refer to these following sections:

2.1 Project Findings – IEC Vs AS/NZS Load

Total Water Consumption

Use of IEC load is unlikely to result in any significant difference in total water consumption compared to runs conducted using the AS/NZS load. On average the difference in water consumption was found to be less than 1.5%, which is within the repeatability of the machine performance.

Hot Water Consumption

Use of IEC load is unlikely to result in any significant difference in hot water consumption compared to runs conducted using the AS/NZS load. On average the difference in hot water consumption was found to be less than 2.5% or half a litre, which is within the repeatability of the machine performance.

PAEC

Use of IEC load is likely to result in marginally more favorable performance outcomes in terms of PAEC compared to runs conducted using the AS/NZS load. On average the PAEC was reduced by 1.7%.

SRI

Use of IEC load is likely to provide near identical outcomes in terms of SRI and star rating compared to runs conducted using the AS/NZS load. The maximum observed difference in the star rating index was only 0.03 points, which is within the repeatability of the machine performance.

WEI

Use of IEC load is likely to result in a slightly less favorable performance outcome in terms of WEI compared to runs conducted using the AS/NZS load. However the difference is small (generally less than 0.06) and is unlikely to be an issue except in the rare case of a machine that is right on the performance limit of 1.1. All test machines would easily pass this performance criteria using either load. It should also be noted that due to supply issues, that a new IEC load was used for testing and that this is likely to have a worse WEI performance when compared to an average or old load. The AS/NZS loads were around half way through their life.

Normalised Average Soil Removal

Use of IEC load is likely to result in a slightly more favorable performance outcome in terms of normalized average soil removal compared to runs conducted using the AS/NZS load. Whilst this is true for machines with the most common form of agitators,



impellers and drums there is some evidence that less common forms of these machines that use different mechanical action may produce significantly different results on individual runs. This is however by no means certain and may simply reflect the inherent variability of the particular machine tested. Taking the average result of each pair of runs all machines would pass this performance criteria using either load. Again the relative age of the loads may have a small influence in this performance measure, so this needs to be taken into account.

Standard Deviation

Use of IEC load is likely to produce similar performance outcome in terms of Standard Deviation compared to runs conducted using the AS/NZS load. Whilst this is true for machines with the most common form of agitators, impellers and drums there is some evidence that less common forms of these machines that use different mechanical action may produce significantly different results on individual runs. This is however by no means certain and may simply reflect the inherent variability of the particular machine tested.

SR- 2xSD

Use of IEC load is likely to produce similar performance outcome in terms of SR-2SD compared to runs conducted using the AS/NZS load. Whilst this is true for machines with the most common form of agitators, impellers and drums there is some evidence that less common forms of these machines that use different mechanical action may produce significantly different results on individual runs. This is however by no means certain and may simply reflect the inherent variability of the particular machine tested. All machines except the large agitator passed this performance standard irrespective of the load used. The large agitator failed with either load.

Severity of Washing Action Index

Use of IEC load is likely to result in a slightly less favorable performance outcome in terms of severity of washing action index compared to runs conducted using the AS/NZS load. The difference in absolute terms (approx 0.05 increase) may be an issue for machines that are already close to the performance limit (0.3). Again, there may be a small influence of the relative load age in this performance parameter.

Rinse Performance

Use of IEC load is likely to result in a slightly less favorable performance outcome in terms of rinse performance compared to runs conducted using the AS/NZS load. However the difference is relatively small (averaging 0.15) and again, there may be a small influence of the relative load age in this performance parameter. Even if this difference is not load age related it is unlikely to be an issue except for those machines already on or close to the performance limit (when tested with the AS/NZS load). All machines that passed the performance test using the AS/NZS load also passed using the IEC load. One machine failed the test by a significant margin irrespective of the load used.



Program Time

Use of IEC load is unlikely to result in any significant variation in program time compared to runs conducted using the AS/NZS load.

2.2 Project Findings – Drum Detergent vs Non Drum Detergent

PAEC

Use of Drum detergent in top loaders results in comparable performance outcomes in terms of PAEC compared to runs conducted using the AS/NZS load. On average the PAEC was reduced by 2.3% when using the drum type detergent.

SRI

Use of drum detergents likely to provide near identical outcomes in terms of SRI (typically to one decimal place) and identical star rating compared to runs conducted using the non drum detergent.

WEI

Use of drum type detergent is likely to result in a marginally less favorable performance outcome in terms of WEI compared to runs conducted using the non drum detergent. However the difference is very small (generally less than 0.04) and is unlikely to be an issue except in the rare case of a machine that is on the performance limit of 1.1. All test machines would easily pass this performance criteria using either detergent.

Normalised Average Soil Removal

Use of drum type detergent is likely to result in relatively small differences in performance outcome in terms of average soil removal compared to runs conducted using non drum detergent. The small variations that were observed (typically less than 3 percentage points) were not systematic and probably due to inherent variability within each test machine.

SD

Use of drum type detergent is likely to produce similar performance outcome in terms of Standard Deviation compared to runs conducted using non drum detergent. The variations that were observed (typically less than 2 percentage points) were not systematic and probably due to inherent variability within the particular test machines.

SR – 2xSD

Use of drum detergent is likely to produce similar performance outcome in terms of SR-2xSD compared to runs conducted using non drum detergent. All machines except the large agitator passed this performance standard irrespective of the detergent used. The large agitator failed with either detergent (using average of the two runs).



Severity of Washing Action Index

Use of drum detergent is likely to produce similar performance outcomes in terms of severity of wash compared to runs conducted using non drum detergent. All machines except the small agitator passed this performance standard irrespective of the detergent used. The small agitator failed with either detergent.

Rinse Performance

Use of drum detergent appears to have no systematic impact on rinse performance results compared to those obtained using non drum detergent. Observed minor differences associated with particular machines appear to be a result of inherent variability associated with the particular test machine.

2.3 Recommendations

Recommendation 1

That the use of the IEC load be included as an option for use when testing clothes washers to the AS/NZS 2040.1 standard and further that it be a requirement of the part 2 standard that the type of load used be recorded in the application form.

Recommendation 2

That at the time of the introduction of the option for using the IEC load, a sunset date be included in AS/NZS 2040.1 for the use of the current AS/NZS load.

Recommendation 3

That a sunset date be included in AS/NZS 2040.1 for the use of the current AS/NZS non drum detergent and further that it be a requirement of the part 2 standard that the type of detergent used be recorded in the application form (noting that the use of the current IEC B detergent for top load testing is already an option available in this standard).

Recommendation 4

Current performance limits to be left unaltered i.e. irrespective of the type of load or type of detergent used.

Recommendation 5

That compliance testing (check tests) shall be conducted using the same load type and detergent type as used for registration purposes.



3. Test Results – AS/NZS versus IEC Load

3.1 Introduction

Following are the test results for repeatability testing under current AS/NZS Standard conditions and Comparative testing of IEC load and AS/NZS load

Critical performance measures undertaken include mandatory minimum performance requirements as set out in the Standard AS/NZS 2040.2 plus the hot water consumption and PAEC which largely determines the energy star rating for the machine and the total water consumption that largely determines the water star rating of the machine. The following measurements were compared between runs conducted using the AS/NZS load and runs conducted using the IEC load :

- Total water consumption
- Total Hot Water consumption
- PAEC
- SRI
- WEI
- normalized average soil removal
- SD
- SR - 2 x SD
- severity of washing action index
- rinse performance score
- cycle time

In the overall analysis tables that are included in the following sections an extra column has been added to the results associated with soil removal performance. This second column presents results exclusive of those obtained for the large agitator machine. This machine produced significantly different soil removal results when using the IEC load. It is postulated that these differences are attributable to the unique agitator form for this machine (see Figure 7) and are therefore unlikely to affect standard agitator type machines.



3.2 Critical Performance Measures - Total water consumption

3.2.1 The Measure

Total Water Consumption is the total of all hot and cold water consumed during the test including any water used to dissolve the detergent. This measure impacts on Water rating and energy consumption calculations.

3.2.2 Results Tables

Table 1 : Total Water Consumption Results – Individual Runs

Total Water Consumption	Small Agitator	Large Agitator	Small Impeller	Large Impeller	Small Drum	Large Drum
AS/NZS range (Litres)	78.4-79.8	135-135.8	67.3-68.8	178-179	73.7-75.1	70.5-73.5
IEC range (Litres)	79.3-80.4	134.5-136	67.5-68.4	179-180	69.7-70.8	66.1-67
IEC Variation From AS/NZS range (Litres)	-0 to +0.6	-0.4 to +0	-0 to +0	-0 to +1.1	-4 to +0	-4.4 to +0
IEC Variation From AS/NZS range (%)	-0% to +0.75%	-0.3% to +0%	-0% to +0%	-0% to +0.62%	-5.43% to +0%	-6.24% to +0%

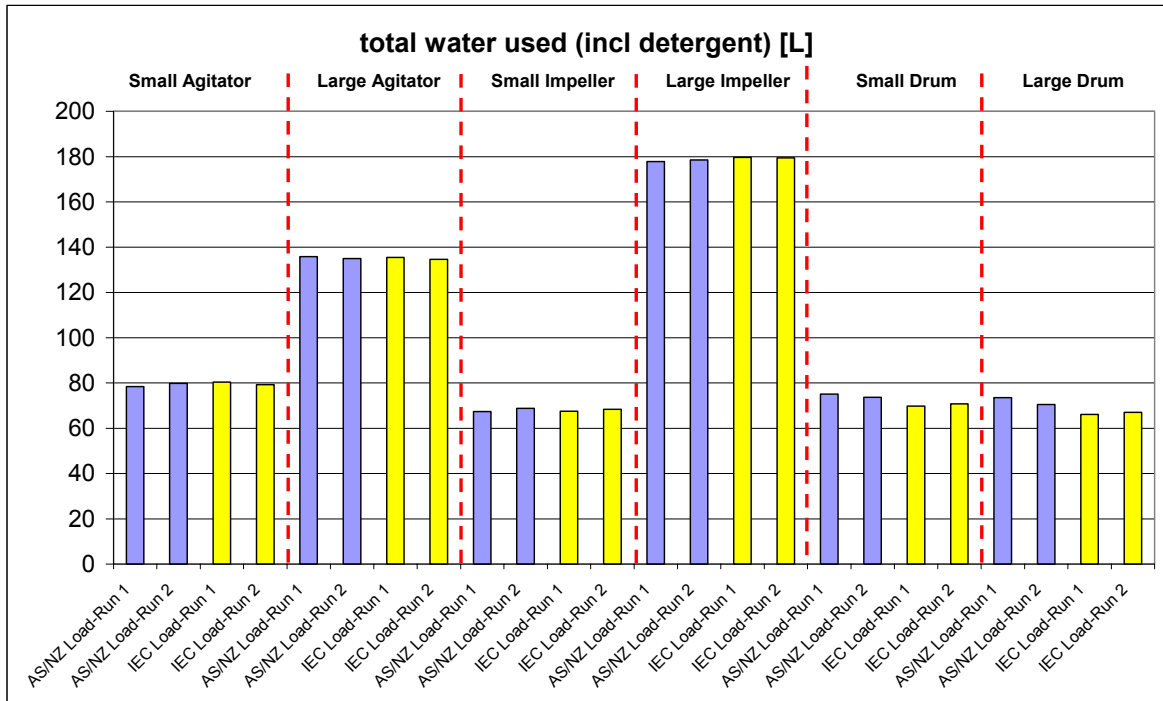
Table 2 : Total Water Consumption Results – Overall analysis

Total Water Consumption	All Runs	
	(Litres)	%
Maximum Below AS/NZS	4.40	6.24
Maximum above AS/NZS	1.10	0.75



3.2.3 Results Graphical

Figure 1 : Total Water Consumption Results– Individual Runs



3.2.4 Analysis

Compared to runs conducted using the AS/NZS load, runs conducted using the IEC load generally produce a slightly lower water consumption result. The amount varies from machine to machine. Top loaders show little variation (less than 1 litre) whereas front loaders show more variation (approx 4 litres or 6% less consumption). On average the difference in water consumption was found to be less than 1.5%

3.2.5 Findings

Use of IEC load is unlikely to result in any significant difference in total water consumption compared to runs conducted using the AS/NZS load. On average the difference in water consumption was found to be less than 1.5%



3.3 Critical Performance Measures - Total Hot Water Consumption

3.3.1 The Measure

Total Hot Water Consumption is the total of all hot water consumed (via the inlet pipes) during the test. This measure impacts on Water rating and energy consumption calculations.

3.3.2 Results Tables

Table 3 : Total Hot Water Consumption Results – Individual Runs

Total Hot Water Consumption	Small Agitator	Large Agitator	Small Impeller	Large Impeller	Small Drum	Large Drum
ASNZS range (Litres)	196-196	36-36.1	299-304	35.5-36	NA	NA
IEC range (Litres)	192-196	35.2-35.4	30.2-30.5	33.4-34	NA	NA
IEC Variation From ASNZS range (Litres)	-0.4 to +0	-0.8 to +0	-0 to +0.1	-2.1 to +0	NA	NA
IEC Variation From ASNZS range (%)	-2% to +0%	-2.2% to +0%	-0% to +0.3%	-5.9% to +0%	NA	NA

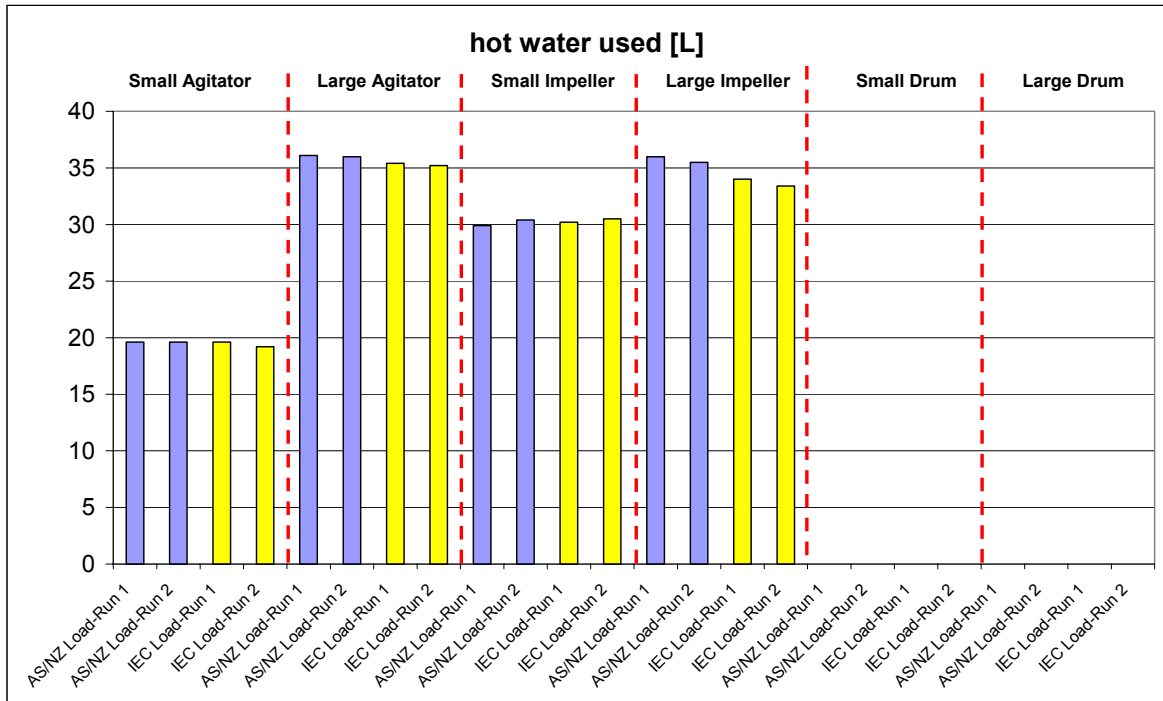
Table 4 : Total Hot Water Consumption Results – Overall analysis

Total Hot Water Consumption	All Runs	
	(Litres)	%
Maximum Below AS/NZS	2.10	5.9%
Maximum above AS/NZS	0.10	0.3%



3.3.3 Results Graphical

Figure 2 : Total Hot Water Consumption Results – Individual Runs



3.3.4 Analysis

Compared to runs conducted using the AS/NZS load, runs conducted using the IEC load generally produce a slightly lower hot water consumption result. The amount varies from machine to machine with a maximum reduction of 2.1 litres or 5.9%. On average the difference in hot water consumption was found to be less than 2.5% or half a litre.

3.3.5 Findings

Use of IEC load is unlikely to result in any significant difference in hot water consumption compared to runs conducted using the AS/NZS load. On average the difference in hot water consumption was found to be less than 2.5% or half a litre.

3.4 Critical Performance Measures – PAEC

3.4.1 The Measure

PAEC is the total energy consumed during the test multiplied by 365. This measure impacts on the labeled energy consumption and the star rating calculations

3.4.2 Results Tables

Table 5 : PAEC Results – Individual Runs

PAEC	Small Agitator	Large Agitator	Small Impeller	Large Impeller	Small Drum	Large Drum
ASNZS range (kWh/annum)	431-432	757-759	552-561	620-697	295-311	341-368
IEC range (kWh/annum)	422-429	741-742	557-562	651-661	287-299	314-354
IEC Variation From ASNZS range (kWh/annum)	-9 to +0	-16 to +0	-0 to +1	-0 to +0	-8 to +0	-27 to +0
IEC Variation From ASNZS range (%)	-2.1% to +0%	-2.1% to +0%	-0% to +0.2%	-0% to +0%	-2.7% to +0%	-7.9% to +0%

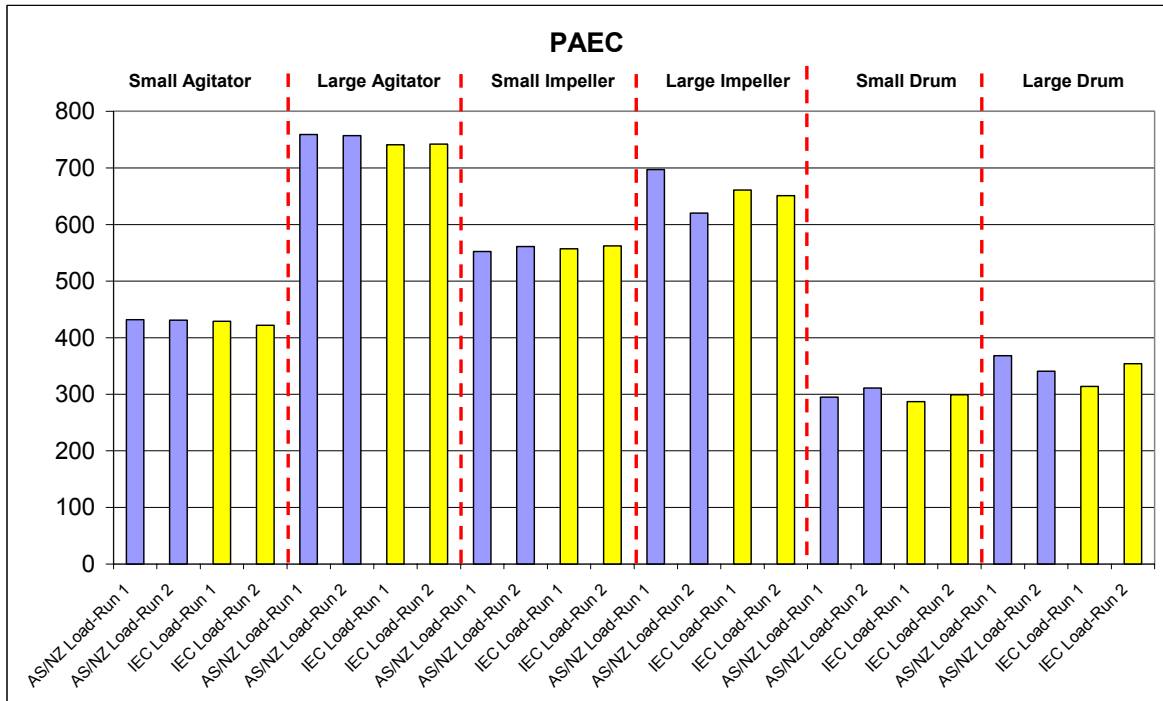
Table 6 : PAEC Results – Overall analysis

PAEC	All Runs	
	(kWh/annum)	%
Maximum Below AS/NZS	27.0	7.9
Maximum above AS/NZS	1.0	0.2



3.4.3 Results Graphical

Figure 3 : PAEC Results – Individual Runs



3.4.4 Analysis

Compared to runs conducted using the AS/NZS load, runs conducted using the IEC load generally produce a slightly lower energy consumption result. The amount varies from machine to machine (typically between 0 and 2.5%) with the largest reduction in the large front loader 7.9%

3.4.5 Findings

Use of IEC load is likely to result in marginally more favorable performance outcomes in terms of PAEC compared to runs conducted using the AS/NZS load. On average the PAEC was reduced by 1.7%.



3.5 Critical Performance Measures – SRI

3.5.1 The Measure

SRI is the index of energy performance. For a machine of given rated capacity SRI is based primarily upon the PAEC, the other factor influencing SRI is the Water extraction index WEI . This measure impacts on the labeled star rating.

3.5.2 Results Tables

Table 7 : SRI Results – Individual Runs

SRI	Small Agitator	Large Agitator	Small Impeller	Large Impeller	Small Drum	Large Drum
AS/NZS range (SRI)	223-223	1.69-1.69	1.48-1.55	1.93-2.21	2.91-3.09	3.71-3.86
IEC range (SRI)	222-224	1.69-1.71	1.5-1.52	2.02-2.06	3-3.11	3.68-3.95
IEC Variation From AS/NZS range (SRI)	-0.01 to +0.01	-0 to +0.02	-0 to +0	-0 to +0	-0 to +0.02	-0.03 to +0.09
IEC Variation From AS/NZS range (%)	-0.4% to +0.4%	-0% to +1.2%	-0% to +0%	-0% to +0%	-0% to +0.6%	-0.8% to +2.3%

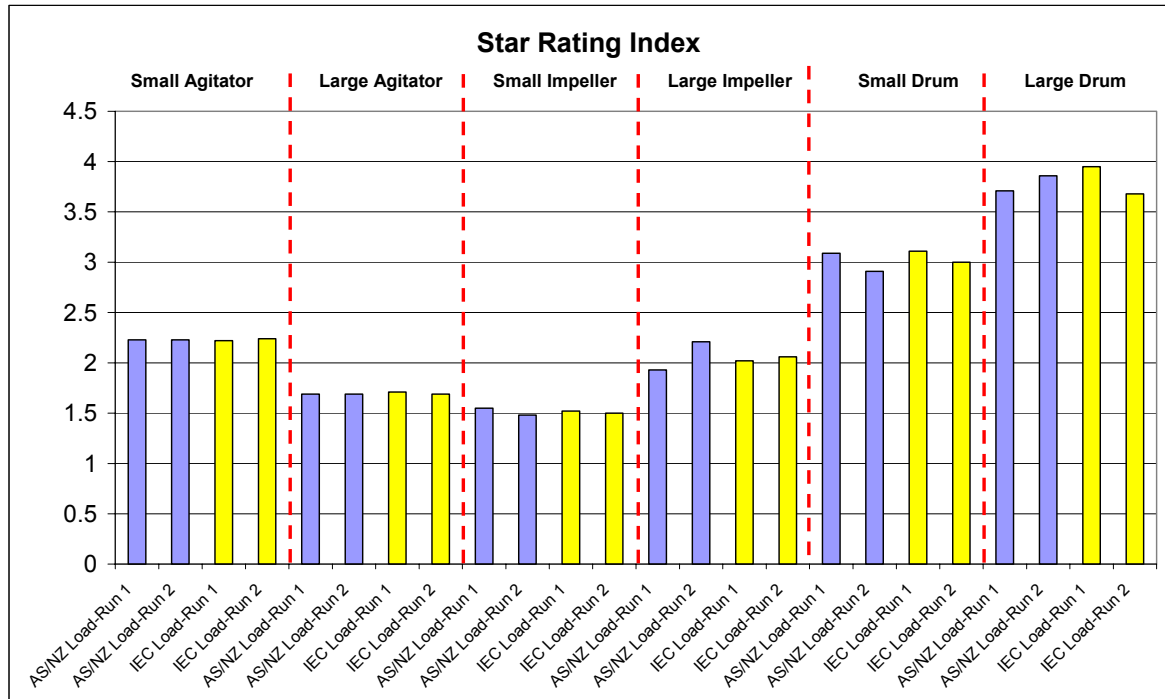
Table 8 : SRI Results – Overall analysis

SRI	All Runs	
	(SRI points)	%
Maximum Below AS/NZS	0.03	0.80
Maximum above AS/NZS	0.09	2.30



3.5.3 Results Graphical

Figure 4 : SRI Results – Individual Runs



3.5.4 Analysis

Use of IEC load produced almost identical performance outcome in terms of SRI compared to runs conducted using the AS/NZS load. The largest variation was for the large front loader that returned values 0.03 lower and 0.09 higher for the IEC load compared to the AS/NZS load (ie less than 0.1 variation). If the results for the 2 runs (for each load type) are averaged the star rating returned in each case would be the same. It is observed that the generally slightly lower PAEC results for the IEC loads appear to counterbalance the generally lower WEI results for the AS/NZS loads

3.5.5 Findings

Use of IEC load is likely to provide near identical outcomes in terms of SRI and star rating compared to runs conducted using the AS/NZS load. The maximum observed difference was only 0.03 points.

3.6 Critical Performance Measures – WEI

3.6.1 The Measure

WEI is the measure of water extraction performance. This measure impacts on the SRI and constitutes a minimum performance standard (must not exceed 1.1)

3.6.2 Results Tables

Table 9 : WEI Results – Individual Runs

WEI	Small Agitator	Large Agitator	Small Impeller	Large Impeller	Small Drum	Large Drum
ASNZS range (WEI)	0.68-0.69	0.76-0.77	0.76-0.79	0.74-0.74	0.71-0.76	0.53-0.54
IEC range (WEI)	0.72-0.73	0.81-0.82	0.76-0.77	0.77-0.77	0.74-0.76	0.59-0.6
IEC Variation From ASNZS range (WEI)	-0 to +0.04	-0 to +0.05	-0 to +0	-0 to +0.03	-0 to +0	-0 to +0.06
IEC Variation From ASNZS range (%)	-0% to +5.8%	-0% to +6.5%	-0% to +0%	-0% to +4.1%	-0% to +0%	-0% to +11.1%

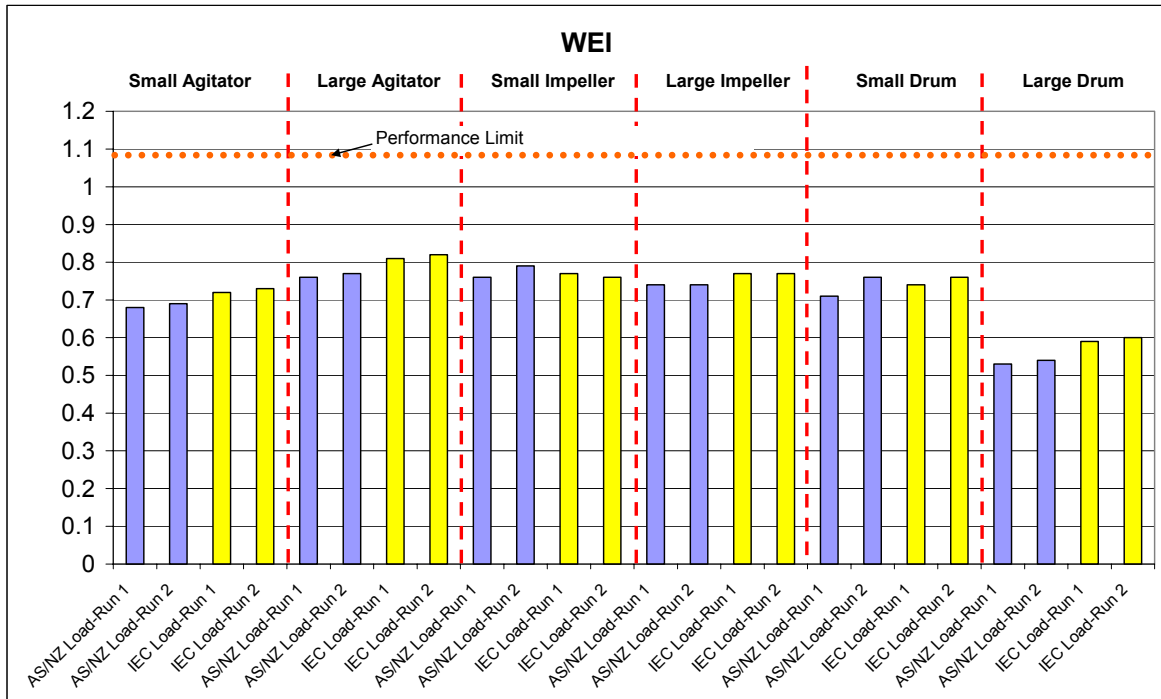
Table 10 : WEI Results – Overall analysis

WEI	All Runs	
	(WEI points)	%
Maximum Below AS/NZS	-	-
Maximum above AS/NZS	0.06	11.10



3.6.3 Results Graphical

Figure 5 : WEI Results – Individual Runs



3.6.4 Analysis

Compared to runs conducted using the AS/NZS load, runs conducted using the IEC load generally produce a marginally poorer (higher) performance result. The amount varies from machine to machine with a maximum of +0.06

3.6.5 Findings

Use of IEC load is likely to result in a slightly less favorable performance outcome in terms of WEI compared to runs conducted using the AS/NZS load. However the difference is small (generally less than 0.06) and is unlikely to be an issue except in the rare case of a machine that is right on the performance limit of 1.1. All test machines would easily pass this performance criteria using either load. It should also be noted that due to supply issues, that a new IEC load was used for testing and that this is likely to have a worse WEI performance when compared to an average or old load. The AS/NZS loads were around half way through their life.

3.7 Critical Performance Measures - normalized avg. soil removal

3.7.1 The Measure

Average Soil removal is the measure of wash performance. This measure constitutes a minimum performance standard (must not be less than 80%)

3.7.2 Results Tables

Table 11 : Average Soil removal Results – Individual Runs

Av. Soil Removal	Small Agitator	Large Agitator	Small Impeller	Large Impeller	Small Drum	Large Drum
AS/NZS range (SR)	865-883	829-83	823-84.5	829-83.5	84.7-87.3	87.2-88
IEC range (SR)	87.6-89	78.1-85.4	83.9-85.2	82.2-84.8	87.2-88.1	88.3-88.8
IEC Variation From AS/NZS range (SR)	-0 to +0.7	-4.8 to +2.4	-0 to +0.7	-0.7 to +1.3	-0 to +0.8	-0 to +0.8
IEC Variation From AS/NZS range (%)	-0% to +0.8%	-5.8% to +2.9%	-0% to +0.8%	-0.8% to +1.6%	-0% to +0.9%	-0% to +0.9%

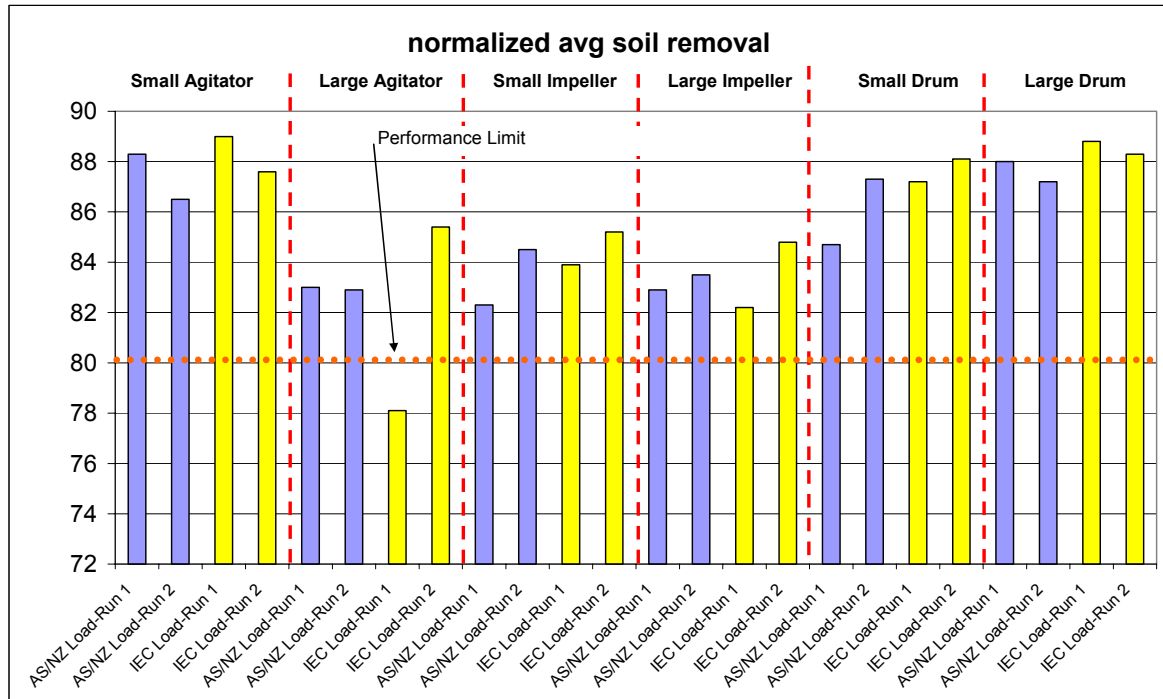
Table 12 : Average Soil Removal Results – Overall analysis

Av. Soil Removal	All Runs		All Runs except Large Agitator	
	(Soil Removal)	%	(Soil Removal)	%
Maximum Below AS/NZS	4.80	5.80	0.70	0.80
Maximum above AS/NZS	2.40	2.90	1.30	1.60



3.7.3 Results Graphical

Figure 6 : Average Soil Removal Results – Individual Runs



3.7.4 Analysis

Compared to runs conducted using the AS/NZS load, runs conducted using the IEC load can generally produce a marginally improved performance result (not more than 1.3% improvement). This observation is true for all machines except the large agitator. This machine produced significantly different soil removal results when using the IEC load (2.4 percentage points better on one run and 4.8 percentage points worse on the second run). The variable result achieved for the large agitator is postulated to be attributable to the particular agitator form for this machine which is not very common in the Australian market in terms of total sales (see Figure 7). Notwithstanding these differences the average of the 2 runs using the IEC load was within one percentage point of the average of the two runs using the AS/NZS load

3.7.5 Findings

Use of IEC load is likely to result in a slightly more favorable performance outcome in terms of normalized average soil removal compared to runs conducted using the AS/NZS load. Whilst this is true for machines with the most common form of agitators, impellers and drums there is some evidence that less common forms of these machines that use different actions may produce significantly different results on individual runs. This is however by no means certain and may simply reflect the

inherent variability of the particular machine tested. Taking the average result of each pair of runs all machines would pass this performance criteria using either load.

Figure 7 Images of the agitator in the large agitator machine

Note: Video of the operation of this agitator is available



3.8 Critical Performance Measures – SD

3.8.1 The Measure

Standard Deviation is the measure of the consistency of soil removal throughout the load. This measure impacts on the SR-2xSD value which constitutes a minimum performance standard (must not be less than 72%)

3.8.2 Results Tables

Table 13 : Standard Deviation Results – Individual Runs

Standard Deviation	Small Agitator	Large Agitator	Small Impeller	Large Impeller	Small Drum	Large Drum
AS/NZS range (SD)	23-43	6-67	21-47	29-34	06-18	1-18
IEC range (SD)	3-36	53-96	31-43	35-36	06-12	06-08
IEC Variation From AS/NZS range (SD)	-0to+0	-0.7to+29	-0to+0	-0to+02	-0to+0	-0.4to+0
IEC Variation From AS/NZS range (%)	-0%to+0%	-11.7%to+43.3%	-0%to+0%	-0%to+5.9%	-0%to+0%	-40%to+0%

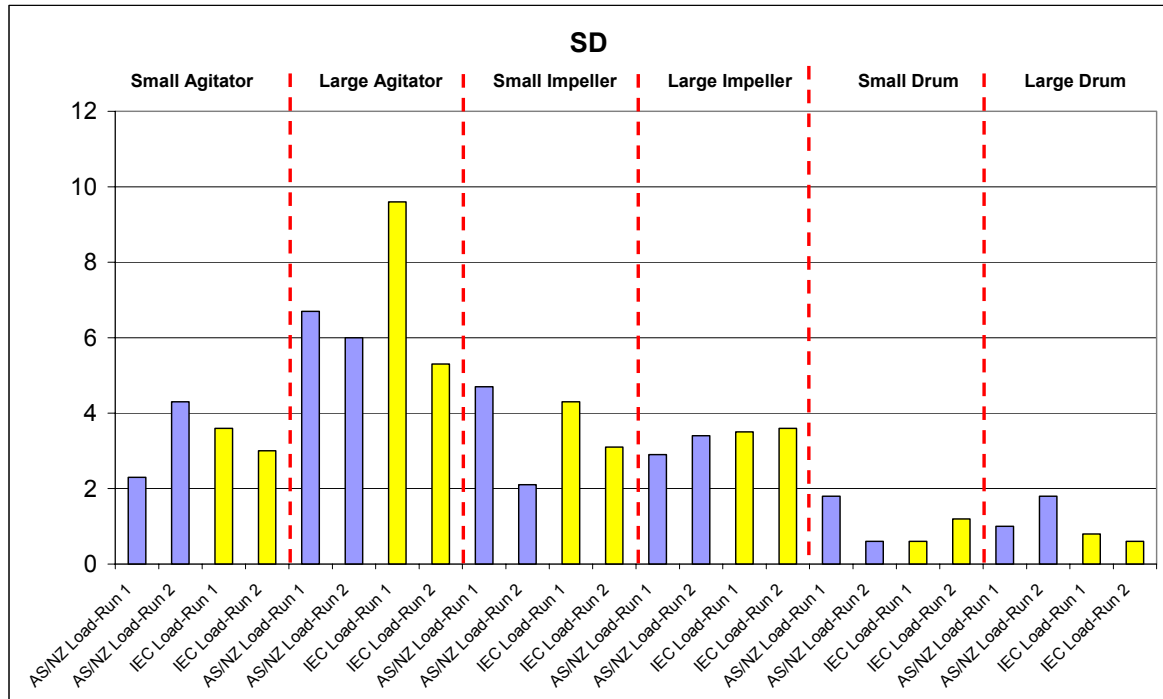
Table 14 : Standard Deviation Results – Overall analysis

Standard Deviation	All Runs		All Runs except Large Agitator	
	(SD points)	%	(SD points)	%
Maximum Below AS/NZS	0.70	40.00	0.40	40.00
Maximum above AS/NZS	2.90	43.30	0.20	5.90



3.8.3 Results Graphical

Figure 8 : Standard Deviation Results – Individual Runs



3.8.4 Analysis

With the exception of the large agitator all machines produced very similar SD results irrespective of the load used. Top loaders ranged from approximately 2 to 4 and front loaders from 1 to 2.

This large agitator produced a significantly different SD results in the first run when using the IEC load (2.9 percentage points worse). The variable result achieved for the large agitator is postulated to be attributable in part to the unique agitator form for this machine (see Figure 7) Whilst this difference is significant it was not repeated in the second run which suggests a higher than average level of variability in the SD result (not uncommon where the SD figure is relatively high)

3.8.5 Findings

Use of IEC load is likely to produce similar performance outcome in terms of Standard Deviation compared to runs conducted using the AS/NZS load. Whilst this is true for machines with the most common form of agitators, impellers and drums there is some evidence that less common forms of these machines that use different actions may produce significantly different results on individual runs. This is however by no means certain and may simply reflect the inherent variability of the particular machine tested.

3.9 Critical Performance Measures - SR - 2 x SD

3.9.1 The Measure

SR-2xSD is the measure of the consistency and absolute soil removal performance throughout the load. This measure constitutes a minimum performance standard (must not be less than 72%)

3.9.2 Results Tables

Table 15 : SR-2xSD Results – Individual Runs

SR – 2xSD	Small Agitator	Large Agitator	Small Impeller	Large Impeller	Small Drum	Large Drum
ASNZS range (SR-2xSD)	77.9-83.7	69.6-70.9	72.9-80.3	76.7-77.1	81.1-86.1	83.6-86
IEC range (SR-2xSD)	81.6-81.8	58.9-74.8	75.3-79	75.2-77.6	85.7-86	87.1-87.2
IEC Variation From ASNZS range (SR-2xSD)	-0 to +0	-10.7 to +3.9	-0 to +0	-1.5 to +0.5	-0 to +0	-0 to +1.2
IEC Variation From ASNZS range (%)	-0% to +0%	-15.4% to +5.5%	-0% to +0%	-2% to +0.6%	-0% to +0%	-0% to +1.4%

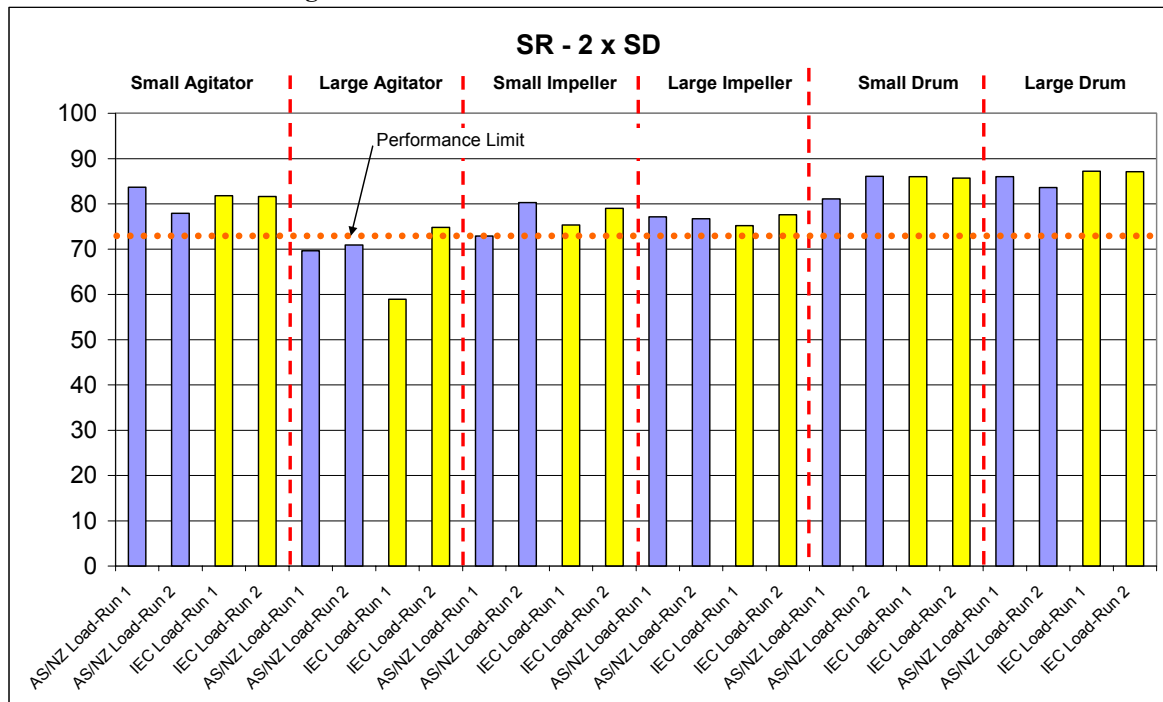
Table 16 : SR-2xSD Results – Overall analysis

SR – 2xSD	All Runs		All Runs except Large Agitator	
	(SR-2xSD)	%	(SR-2xSD)	%
Maximum Below AS/NZS	10.70	15.40	1.50	2.00
Maximum above AS/NZS	3.90	5.50	1.20	1.40



3.9.3 Results Graphical

Figure 9 : SR-2xSD Results Results – Individual Runs



3.9.4 Analysis

With the exception of the large agitator all machines produced very similar SR-2xSD results irrespective of the load used. Results for the IEC load were all within $\pm 1.5\%$ of that produced using the AS/NZS load

This large agitator produced a significantly different SR-2xSD results in the first run when using the IEC load (10.7 percentage points worse). The variable result achieved for the large agitator is postulated to be attributable in part to the unique agitator form for this machine (see Figure 7) Whilst this difference is significant it was not repeated in the second run which suggests a higher than average level of variability especially in the SD result (not uncommon where the SD figure is relatively high) which is then doubled in the SR-2xSD calculation.

3.9.5 Findings

Use of IEC load is likely to produce similar performance outcome in terms of SR-2SD compared to runs conducted using the AS/NZS load. Whilst this is true for machines with the most common form of agitators, impellers and drums there is some evidence that less common forms of these machines that use different actions may produce significantly different results on individual runs. This is however by no means certain and may simply reflect the inherent variability of the particular machine tested. All machines except the large agitator passed this performance standard irrespective of the load used. The large agitator failed with either load.

3.10 Critical Performance Measures - severity of washing action index

3.10.1 The Measure

Severity of Washing Action Index is a measure of how damaging the wash action is to the clothes load in terms of mechanical damage. This measure constitutes a minimum performance standard (must not be more than 0.3)

3.10.2 Results Tables

Table 17 : Severity of Washing Action Index Results – Individual Runs

Severity of Washing Action Index	Small Agitator	Large Agitator	Small Impeller	Large Impeller	Small Drum	Large Drum
AS/NZS range (Fray Index)	0.25-0.28	0.2-0.23	0.15-0.16	0.17-0.22	0.12-0.12	0.13-0.14
IEC range (Fray Index)	0.3-0.34	0.24-0.29	0.19-0.23	0.22-0.22	0.15-0.16	0.15-0.16
IEC Variation From AS/NZS range (Fray Index)	-0 to +0.06	-0 to +0.06	-0 to +0.07	-0 to +0	-0 to +0.04	-0 to +0.02
IEC Variation From AS/NZS range (%)	-0% to +21.4%	-0% to +26.1%	-0% to +43.8%	-0% to +0%	-0% to +33.3%	-0% to +14.3%

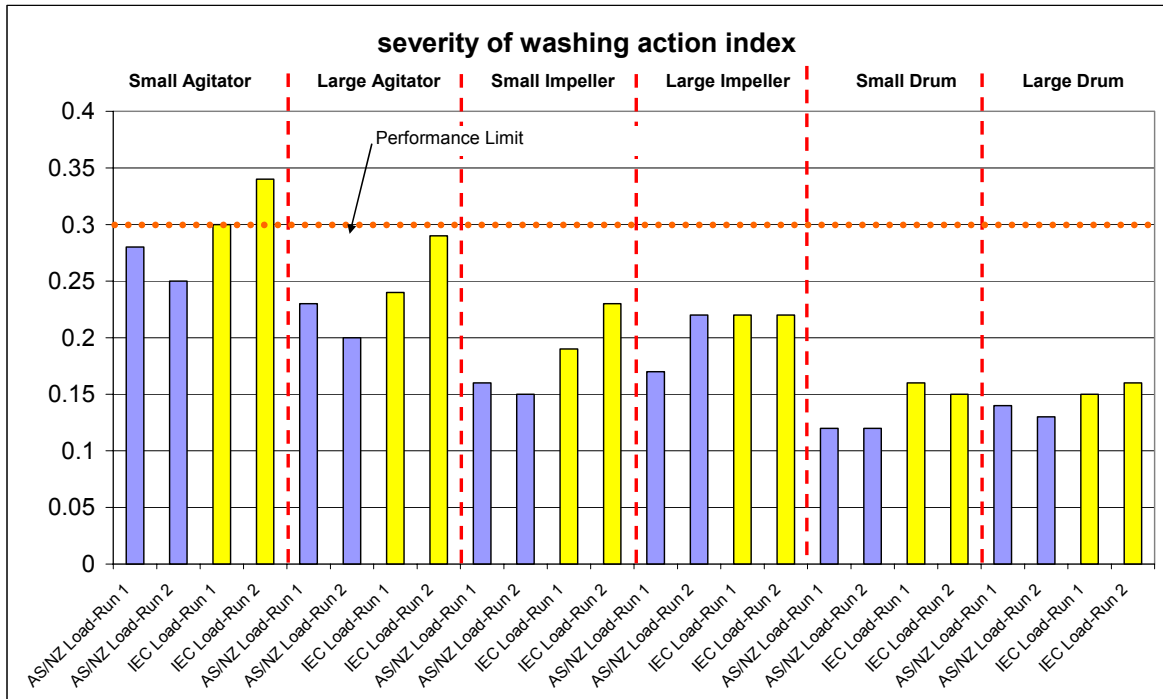
Table 18 : Severity of Washing Action Index Results – Overall analysis

Severity of Washing Action Index	All Runs	
	(kWh/annum)	%
Maximum Below AS/NZS	-	-
Maximum above AS/NZS	0.07	43.80



3.10.3 Results Graphical

Figure 10 : Severity of Washing Action Index Results – Individual Runs



3.10.4 Analysis

Compared to runs conducted using the AS/NZS load, runs conducted using the IEC load generally produce a worse severity of washing action index performance result. The amount can be relatively large in % terms but in absolute terms did not exceed 0.07 points, even so this was sufficient to push the small agitator over the performance limit in its second run (noting that it was already as high as 0.280 in its runs using the AS/NZS load).

3.10.5 Findings

Use of IEC load is likely to result in a slightly less favorable performance outcome in terms of severity of washing action index compared to runs conducted using the AS/NZS load. The difference in absolute terms (approx 0.05 increase) may be an issue for machines that are already close to the performance limit (0.3).



3.11 Critical Performance Measures - Rinse performance

3.11.1 The Measure

Rinse Performance is a measure of how effectively the machine rinses clothes at the end of the cycle. This measure constitutes a minimum performance standard (must not be more than 2.25)

3.11.2 Results Tables

Table 19 : Rinse Performance Results – Individual Runs

Rinse Performance	Small Agitator	Large Agitator	Small Impeller	Large Impeller	Small Drum	Large Drum
ASNZS range (mg/kg of load)	1.93-2.15	1.2-1.66	3.57-3.61	0.8-0.92	1.06-1.22	1.51-1.86
IEC range (mg/kg of load)	1.92-2.25	1.63-1.69	3.39-3.41	0.98-1.18	1.18-1.27	2.19-2.22
IEC Variation From ASNZS range (mg/kg of load)	-0.01 to +0.1	-0 to +0.03	-0.18 to +0	-0 to +0.26	-0 to +0.05	-0 to +0.36
IEC Variation From ASNZS range (%)	-0.5% to +4.7%	-0% to +1.8%	-5% to +0%	-0% to +28.3%	-0% to +4.1%	-0% to +19.4%

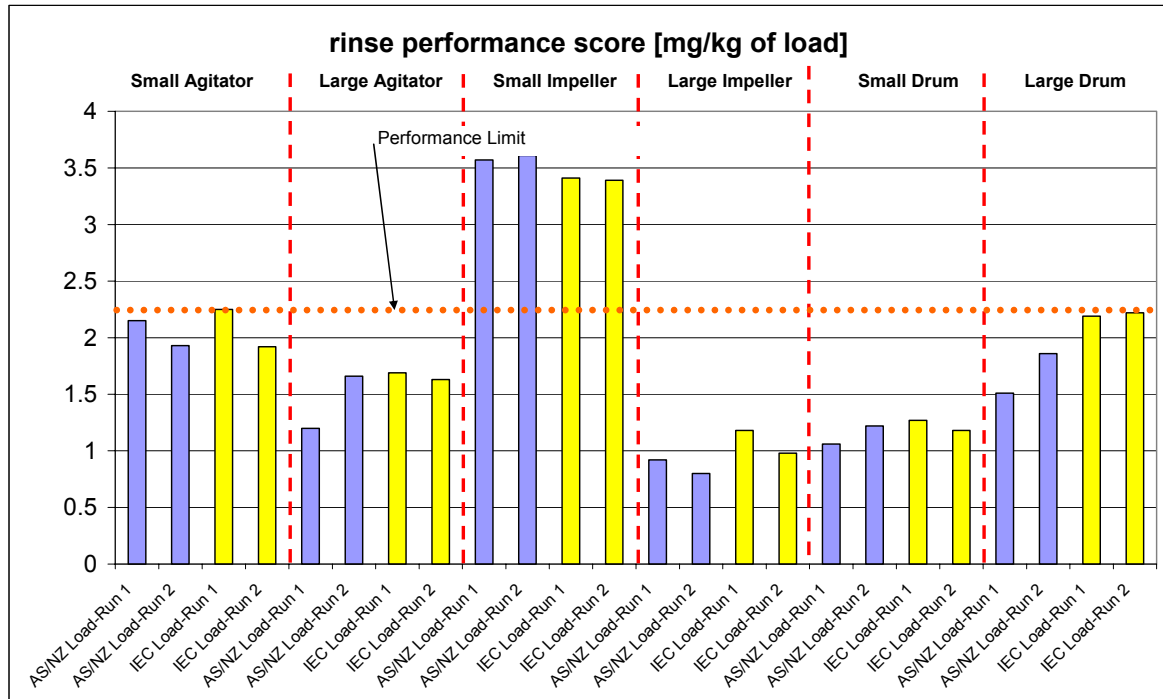
Table 20 : Rinse Performance Results – Overall analysis

Rinse Performance	All Runs	
	(mg/kg load)	%
Maximum Below AS/NZS	0.18	5.00
Maximum above AS/NZS	0.36	28.30



3.11.3 Results Graphical

Figure 11 : Rinse Performance Results – Individual Runs



3.11.4 Analysis

Compared to runs conducted using the AS/NZS load, runs conducted using the IEC load produced a range of differing performance results. Some machines produced worse rinse performance results (up to 0.36 higher) and some machines better results (up to 0.18 lower). On average the result was slightly worse (up 0.15).

3.11.5 Findings

Use of IEC load is likely to result in a slightly less favorable performance outcome in terms of rinse performance compared to runs conducted using the AS/NZS load. However the difference is relatively small (averaging 0.15) and again, there may be a small influence of the relative load age in this performance parameter. Even if this difference is not load age related it is unlikely to be an issue except for those machines already on or close to the performance limit (when tested with the AS/NZS load). All machines that passed the performance test using the AS/NZS load also passed using the IEC load. One machine failed the test by a significant margin irrespective of the load used.

3.12 Critical Performance Measures - Program time

3.12.1 The Measure

Cycle time is the total time elapsed to complete the program.

3.12.2 Results Tables

Table 21 : Program Time Results – Individual Runs

Program Time	Small Agitator	Large Agitator	Small Impeller	Large Impeller	Small Drum	Large Drum
ASNZS range (minutes)	59-59	49-49	43-43	61-61	137-138	140-146
IEC range (minutes)	59-60	50-50	44-44	62-62	138-140	139-144
IEC Variation From ASNZS range (minutes)	-0 to +1	-0 to +1	-0 to +1	-0 to +1	-0 to +2	-1 to +0
IEC Variation From ASNZS range (%)	-0% to +1.7%	-0% to +2%	-0% to +2.3%	-0% to +1.6%	-0% to +1.4%	-0.7% to +0%

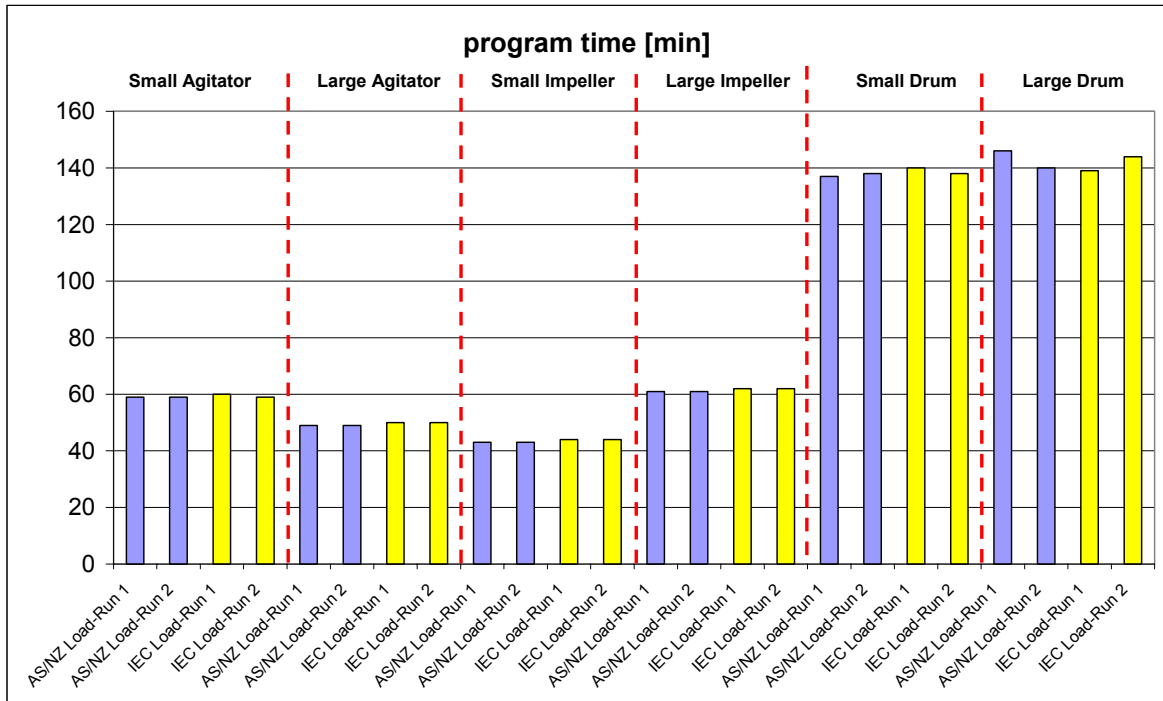
Table 22 : : Program Time Results – Overall analysis

Program Time	All Runs	
	(minutes)	%
Maximum Below AS/NZS	1.00	0.70
Maximum above AS/NZS	2.00	2.30



3.12.3 Results Graphical

Figure 12 : Program Time Results – Individual Runs



3.12.4 Analysis

Compared to runs conducted using the AS/NZS load, runs conducted using the IEC load produce near identical program time results. The variation was typically no more than 1 minute with a maximum variation of only 2 minutes in a front loader with a program time of over 2 hours.

3.12.5 Findings

Use of IEC load is unlikely to result in any significant variation in program time compared to runs conducted using the AS/NZS load.



4. Test Results – Drum Vs Non Drum Detergent (using IEC load in top loaders)

Following are the test results for comparative testing of drum and non drum type detergent in the 4 top loading machines using the IEC load.

Critical performance measures assessed include mandatory minimum performance requirements as set out in the Standard AS/NZS 2040.2 plus the hot water consumption and PAEC which largely determines the energy star rating for the machine and the total water consumption that largely determines the water star rating of the machine. The following measurements were compared between runs conducted using the non drum detergent and the drum type detergent as specified in AS/NZS 2040.1:2005:

- PAEC
- SRI
- WEI
- normalized avg soil removal
- SD
- SR - 2 x SD
- severity of washing action index
- rinse performance score



4.1 Critical Performance Measures – PAEC

4.1.1 The Measure

PAEC is the total energy consumed during the test multiplied by 365. This measure impacts on the labeled energy consumption and the star rating calculations

4.1.2 Results Tables

Table 23 : PAEC Results – Individual Runs

PAEC	Small Agitator	Large Agitator	Small Impeller	Large Impeller
Non Drum range (kWh/annum)	421.9-428.5	741.3-741.7	557–562.5	650.8-660.7
Drum range (kWh/annum)	428.5-435.4	746.4-747.2	555.2-558.5	586.9-596
Drum Detergent Variation From Non Drum range (kWh/annum)	-0 to +6.9	-0 to +5.5	-1.8 to +0	-63.9 to +0
Drum Detergent Variation From Non Drum range (%)	-0% to +1.6%	-0% to +0.7%	-0.3% to +0%	-9.8% to +0%

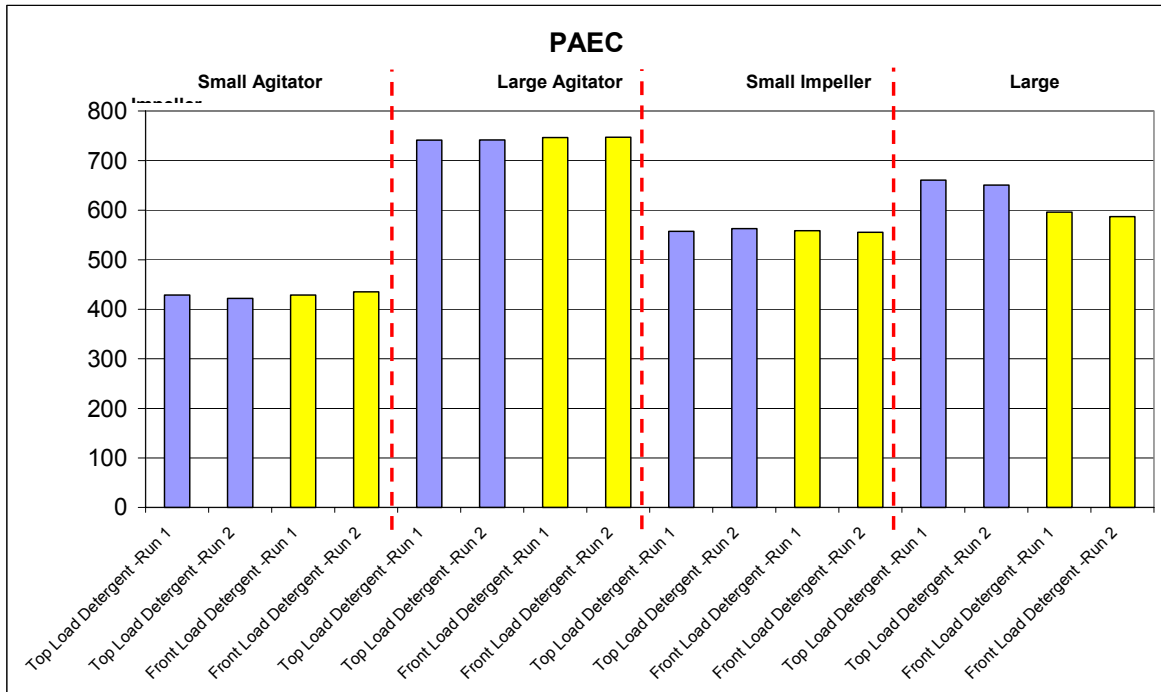
Table 24 : PAEC Results – Overall analysis

PAEC	All Runs	
	(kWh/annum)	%
Maximum Below AS/NZS	63.9	9.8
Maximum above AS/NZS	6.9	1.6



4.1.3 Results Graphical

Figure 13 : PAEC Results – Individual Runs



4.1.4 Analysis

Compared to runs conducted using the non drum detergent, runs conducted using the drum detergent generally produce an equivalent energy consumption result. However, in the case of the large impeller machine there was a reduction in energy consumption of almost 10% using the Drum Detergent compared to the non drum detergent. Analysis has shown that this difference is a result of a reduced intake of hot water (up to 3.8 litres) when using the drum detergent. There appears to be no reason for this increased uptake of hot water, it may simply be inherent variability in the machines performance.

4.1.5 Findings

Use of Drum detergent in top loaders results in comparable performance outcomes in terms of PAEC compared to runs conducted using the AS/NZS load. On average the PAEC was reduced by 2.3% when using the drum type detergent.

4.2 Critical Performance Measures – SRI

4.2.1 The Measure

SRI is the index of energy performance. For a machine of given rated capacity SRI is based primarily upon the PAEC, the other factor influencing SRI is the Water extraction index WEI . This measure impacts on the labeled star rating.

4.2.2 Results Tables

Table 25 : SRI Results – Individual Runs

SRI	Small Agitator	Large Agitator	Small Impeller	Large Impeller
Non Drum Detergent range (SRI)	2.22-2.24	1.69-1.71	1.5-1.52	2.02-2.06
Drum Detergent range (SRI)	2.17-2.21	1.65-1.66	1.48-1.49	2.22-2.26
Drum Detergent Variation From Non Drum range (SRI)	-0.05 to +0	-0.04 to +0	-0.02 to +0	-0 to +0.2
Drum Detergent Variation From Non Drum range (%)	-2.3% to +0%	-2.4% to +0%	-1.3% to +0%	-0% to +9.7%

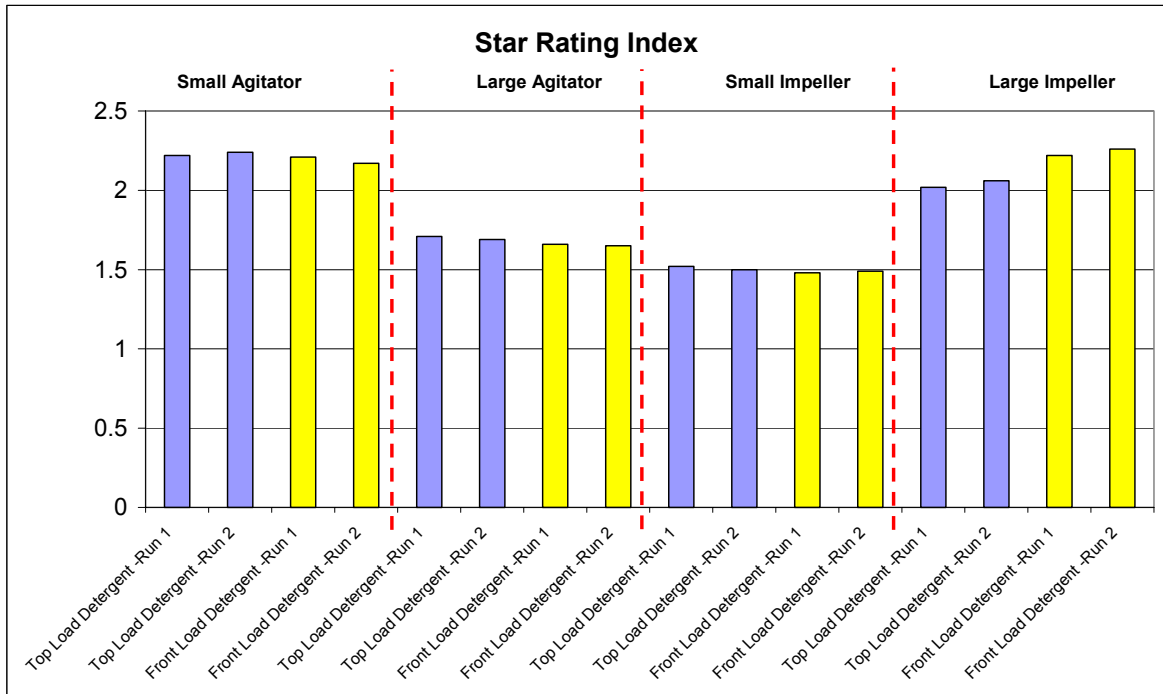
Table 26 : SRI Results – Overall analysis

SRI	All Runs	
	(SRI points)	%
Maximum Below AS/NZS	0.05	2.40
Maximum above AS/NZS	0.20	9.70



4.2.3 Results Graphical

Figure 14 : SRI Results – Individual Runs



4.2.4 Analysis

Use of Drum Detergent produced almost identical performance outcome in terms of SRI compared to runs conducted using the Non Drum Detergent. The largest variation was for the large impeller unit that returned values up to 0.2 higher for the Drum detergent compared to the non drum. For all other machines the SRI was very marginally lower (max 0.05) for the drum type detergent. Irrespective of the detergent used the star rating would be identical for either detergent.

4.2.5 Findings

Use of drum detergents likely to provide near identical outcomes in terms of SRI (typically to one decimal place) and identical star rating compared to runs conducted using the non drum detergent.



4.3 Critical Performance Measures – WEI

4.3.1 The Measure

WEI is the measure of water extraction performance. This measure impacts on the SRI and constitutes a minimum performance standard (must not exceed 1.1).

4.3.2 Results Tables

Table 27 : WEI Results – Individual Runs

WEI	Small Agitator	Large Agitator	Small Impeller	Large Impeller
Non Drum Detergent range (WEI)	0.72-0.73	0.81-0.82	0.76-0.77	0.77-0.77
Drum Detergent range (WEI)	0.72-0.72	0.84-0.85	0.81-0.81	0.81-0.81
Drum Detergent Variation From Non Drum range (WEI)	-0 to +0	-0 to +0.03	-0 to +0.04	-0 to +0.04
Drum Detergent Variation From Non Drum range (%)	-0% to +0%	-0% to +3.7%	-0% to +5.2%	-0% to +5.2%

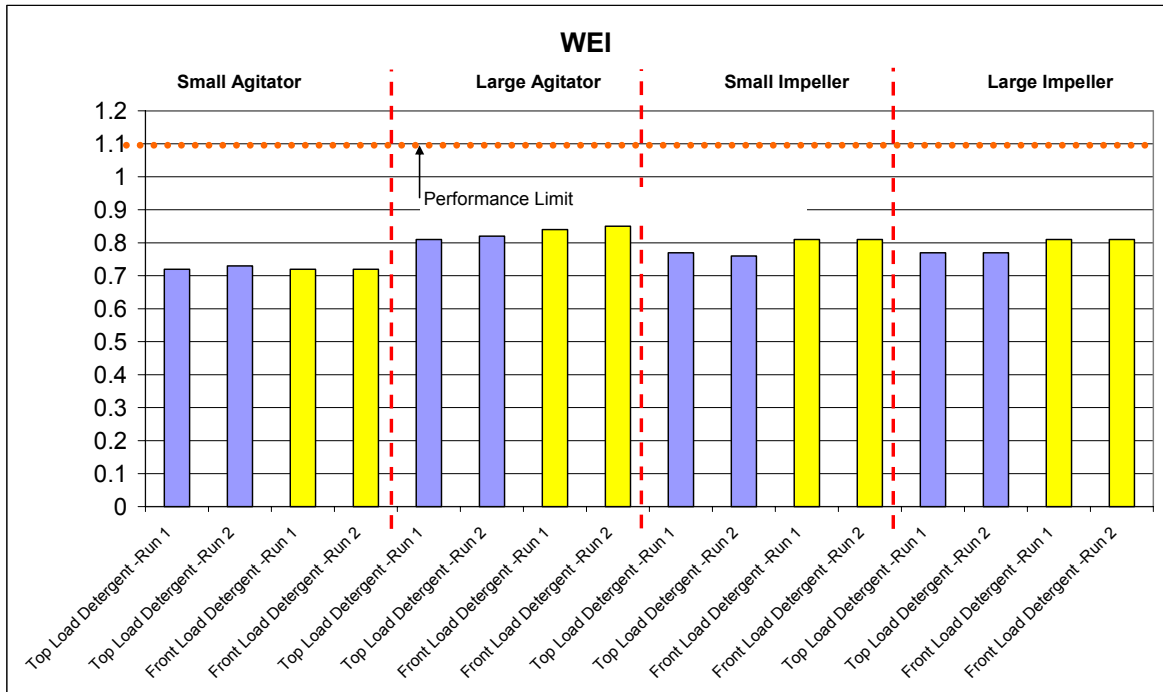
Table 28 : WEI Results – Overall analysis

WEI	All Runs	
	(WEI points)	%
Maximum Below AS/NZS	-	-
Maximum above AS/NZS	0.04	5.20



4.3.3 Results Graphical

Figure 15 : WEI Results – Individual Runs



4.3.4 Analysis

Compared to runs conducted using the non drum detergent, runs conducted using the drum detergent produce a marginally poorer (higher) performance result. The amount varies from machine to machine with a maximum of +0.04.

The reason for this small variation is unclear and may simply reflect natural variability in each machine

4.3.5 Findings

Use of drum type detergent is likely to result in a marginally less favorable performance outcome in terms of WEI compared to runs conducted using the non drum detergent. However the difference is very small (generally less than 0.04) and is unlikely to be an issue except in the rare case of a machine that is on the performance limit of 1.1. All test machines would easily pass this performance criteria using either detergent.



4.4 Critical Performance Measures - normalized avg. soil removal

4.4.1 The Measure

Average Soil removal is the measure of wash performance. This measure constitutes a minimum performance standard (must not be less than 80%).

4.4.2 Results Tables

Table 29 : Average Soil removal Results – Individual Runs

Average Soil Removal	Small Agitator	Large Agitator	Small Impeller	Large Impeller
Non Drum Detergent range (SR)	87.6-89	78.1-85.4	83.9-85.2	82.2-84.8
Drum Detergent range (SR)	85.9-88.3	73.3-79.7	87.1-87.9	84.2-85.2
Drum Detergent Variation From Non Drum range (SR)	-1.7 to +0	-4.8 to +0	-0 to +2.7	-0 to +0.4
Drum Detergent Variation From Non Drum range (%)	-1.9% to +0%	-6.1% to +0%	-0% to +3.2%	-0% to +0.5%

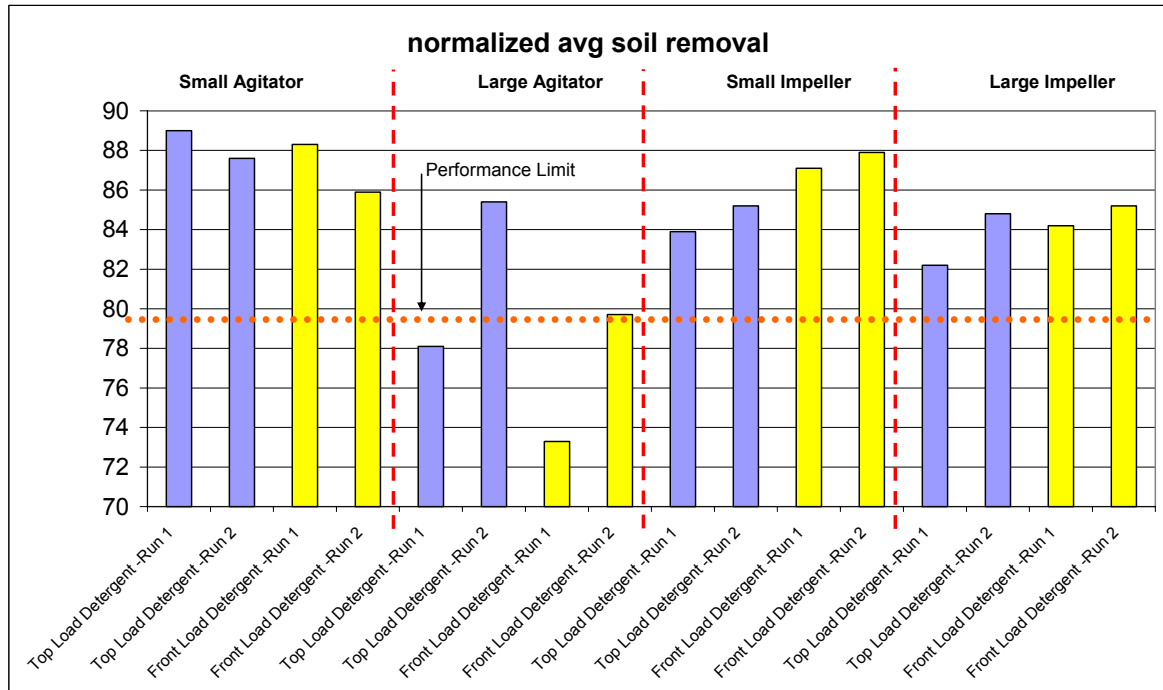
Table 30 : Average Soil Removal Results – Overall analysis

Av. Soil Removal	All Runs	
	(Soil Removal)	%
Maximum Below AS/NZS	4.80	6.10
Maximum above AS/NZS	2.70	3.20



4.4.3 Results Graphical

Figure 16 : Average Soil Removal Results – Individual Runs



4.4.4 Analysis

Compared to runs conducted using non drum detergent, runs conducted using drum detergent generally produce a similar performance result although some variation was observed. The small impeller unit produced results up to 2.7 percentage points better using the drum detergent and the large agitator produced results up to 4.8 percentage points worse (noting that this unit tends to produce less consistent results than the others). Averaged across all units the difference was less than 1 percentage point.

4.4.5 Findings

Use of drum type detergent is likely to result in relatively small differences in performance outcome in terms of average soil removal compared to runs conducted using non drum detergent. The small variations that were observed (typically less than 3 percentage points) were not systematic and probably due to inherent variability within each test machine.

4.5 Critical Performance Measures – SD

4.5.1 The Measure

Standard Deviation is the measure of the consistency of soil removal throughout the load. This measure impacts on the SR-2xSD value which constitutes a minimum performance standard (must not be less than 72%).

4.5.2 Results Tables

Table 31 : Standard Deviation Results – Individual Runs

Standard Deviation	Small Agitator	Large Agitator	Small Impeller	Large Impeller
Non Drum Detergent range (SD)	3-36	53-96	31-43	35-36
Drum Detergent range (SD)	27-48	98-126	14-14	25-31
Drum Detergent Variation From Non Drum range (SD)	-0.3 to +1.2	-0 to +3	-1.7 to +0	-1 to +0
Drum Detergent Variation From Non Drum range (%)	-10% to +33.3%	-0% to +31.3%	-54.8% to +0%	-28.6% to +0%

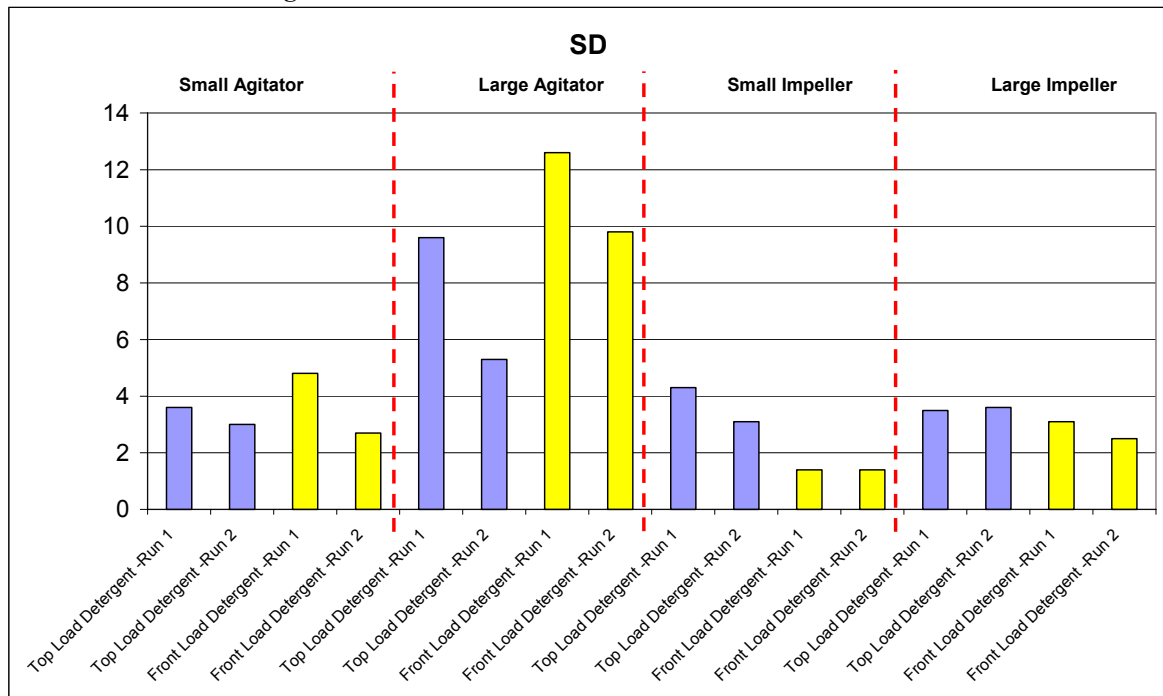
Table 32 : Standard Deviation Results – Overall analysis

Standard Deviation	All Runs	
	(SD points)	%
Maximum Below AS/NZS	1.70	54.80
Maximum above AS/NZS	3.00	33.30



4.5.3 Results Graphical

Figure 17 : Standard Deviation Results – Individual Runs



4.5.4 Analysis

With the exception of the large agitator all machines produced very similar SD results irrespective of the detergent used. The range for the drum type detergent was -1.7 percentage points to +1.2 percentage points outside the range obtained using non drum detergent.

The large agitator produced a SD results using drum type detergent up to 3 percentage points higher than that obtained using non drum type detergent. However this machine returned a relatively high SD result (up to 9.6%) using non drum detergent and an increase to 12.6% for the first run using the drum detergent in relative terms is not that significant (noting that the second run using drum detergent returned a near identical SD result to that obtained in the first run using non drum detergent).

Averaged across all runs, the SD result for the drum type detergent was only 0.3 percentage points higher than that for the non drum detergent.

4.5.5 Findings

Use of drum type detergent is likely to produce similar performance outcome in terms of Standard Deviation compared to runs conducted using non drum detergent. The variations that were observed (typically less than 2 percentage points) were not systematic and probably due to inherent variability within the particular test machines.



4.6 Critical Performance Measures - SR - 2 x SD

4.6.1 The Measure

SR-2xSD is the measure of the consistency and absolute soil removal performance throughout the load. This measure constitutes a minimum performance standard (must not be less than 72%).

4.6.2 Results Tables

Table 33 : SR-2xSD Results – Individual Runs

SR-2SD	Small Agitator	Large Agitator	Small Impeller	Large Impeller
Non Drum Detergent range (SR-2xSD)	81.6-81.8	58.9-74.8	75.3-79	75.2-77.6
Drum Detergent range (SR-2xSD)	78.7-80.5	48.1-60.1	84.3-85.1	78-80.2
Drum Detergent Variation From Non Drum range (SR-2xSD)	-2.9 to +0	-10.8 to +0	-0 to +6.1	-0 to +2.6
Drum Detergent Variation From Non Drum range (%)	-3.6% to +0%	-18.3% to +0%	-0% to +7.7%	-0% to +3.4%

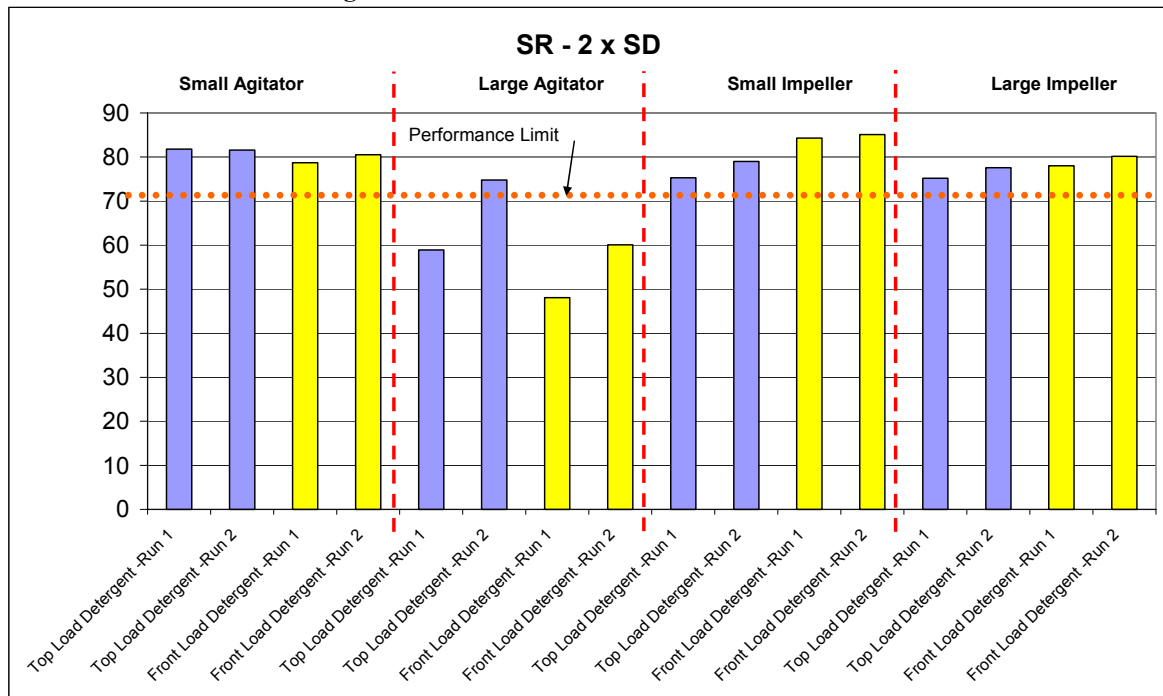
Table 34 : SR-2xSD Results – Overall analysis

SR – 2xSD	All Runs	
	(SR-2xSD)	%
Maximum Below AS/NZS	10.80	18.30
Maximum above AS/NZS	6.10	7.70



4.6.3 Results Graphical

Figure 18 : SR-2xSD Results – Individual Runs



4.6.4 Analysis

On average the SR-2xSD result using drum detergent was very similar to that obtained for the non drum detergent (within 1.2 percentage points averaged across all runs) however variations for individual machines were in some cases more significant

The large agitator in particular produced a significantly different SR-2xSD results in the first run when using the drum detergent (10.8 percentage points worse). Whilst this difference is significant it was not repeated in the second run which suggests a higher than average level of variability especially in the SD result (not uncommon where the SD figure is relatively high) which is then doubled in the SR-2xSD calculation.

4.6.5 Findings

Use of drum detergent is likely to produce similar performance outcome in terms of SR-2xSD compared to runs conducted using non drum detergent. All machines except the large agitator passed this performance standard irrespective of the detergent used. The large agitator failed with either detergent (using average of the two runs).

4.7 Critical Performance Measures - severity of washing action index

4.7.1 The Measure

Severity of Washing Action Index is a measure of how damaging the wash action is to the clothes load in terms of mechanical damage. This measure constitutes a minimum performance standard (must not be more than 0.3).

4.7.2 Results Tables

Table 35 : Severity of Washing Action Index Results – Individual Runs

Severity of Washing Action Index	Small Agitator	Large Agitator	Small Impeller	Large Impeller
Non Drum Detergent range (Fray Index)	0.3-0.34	0.24-0.29	0.19-0.23	0.22-0.22
Drum Detergent range (Fray Index)	0.32-0.34	0.19-0.23	0.23-0.24	0.22-0.23
Drum Detergent Variation From Non Drum range (Fray Index)	-0 to +0	-0.05 to +0	-0 to +0.01	-0 to +0.01
Drum Detergent Variation From Non Drum range (%)	-0% to +0%	-20.8% to +0%	-0% to +4.3%	-0% to +4.5%

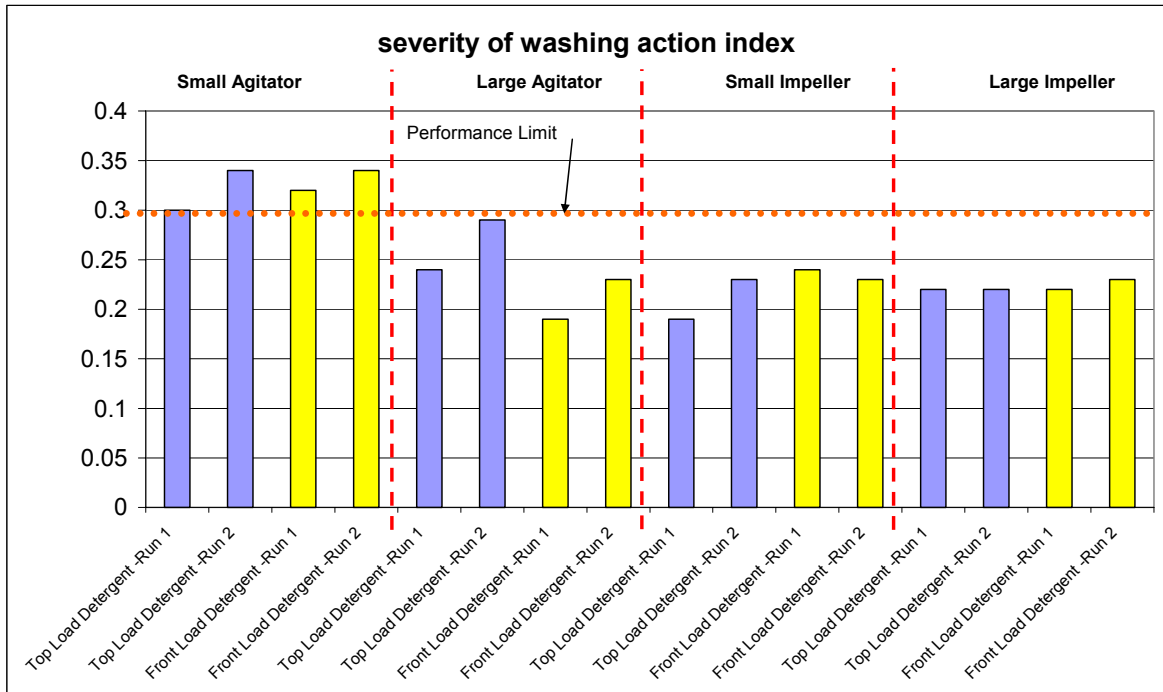
Table 36 : Severity of Washing Action Index Results – Overall analysis

Severity of Washing Action Index	All Runs	
	(kWh/annum)	%
Maximum Below AS/NZS	0.05	20.80
Maximum above AS/NZS	0.01	4.50



4.7.3 Results Graphical

Figure 19 : Severity of Washing Action Index Results – Individual Runs



4.7.4 Analysis

Compared to runs conducted using the non drum detergent, runs conducted using the drum detergent generally produced a comparable severity of washing action index performance result. Differences where they did occur could be relatively large in % terms but in absolute terms did not exceed 0.05 points. Taking the average of all runs using drum detergent compared to the average of all runs using non drum detergent the difference was only 0.003 points. All units that passed the performance measure using the non drum detergent also passed using the drum detergent. The small agitator failed the performance measure irrespective of the detergent used.

4.7.5 Findings

Use of drum detergent is likely to produce similar performance outcomes in terms of severity of wash compared to runs conducted using non drum detergent. All machines except the small agitator passed this performance standard irrespective of the detergent used. The small agitator failed with either detergent.



4.8 Critical Performance Measures - Rinse performance

4.8.1 The Measure

Rinse Performance is a measure of how effectively the machine rinses clothes at the end of the cycle. This measure constitutes a minimum performance standard (must not be more than 2.25).

4.8.2 Results Tables

Table 37 : Rinse Performance Results – Individual Runs

Rinse Performance	Small Agitator	Large Agitator	Small Impeller	Large Impeller
Non Drum Detergent range (mg/kg of load)	1.92-2.25	1.63-1.69	3.39-3.41	0.98-1.18
Drum Detergent range (mg/kg of load)	2.05-2.25	1.36-1.41	3.79-3.82	0.68-0.78
Drum Detergent Variation From Non Drum range (mg/kg of load)	-0 to +0	-0.27 to +0	-0 to +0.41	-0.3 to +0
Drum Detergent Variation From Non Drum range (%)	-0% to +0%	-16.6% to +0%	-0% to +12%	-30.6% to +0%

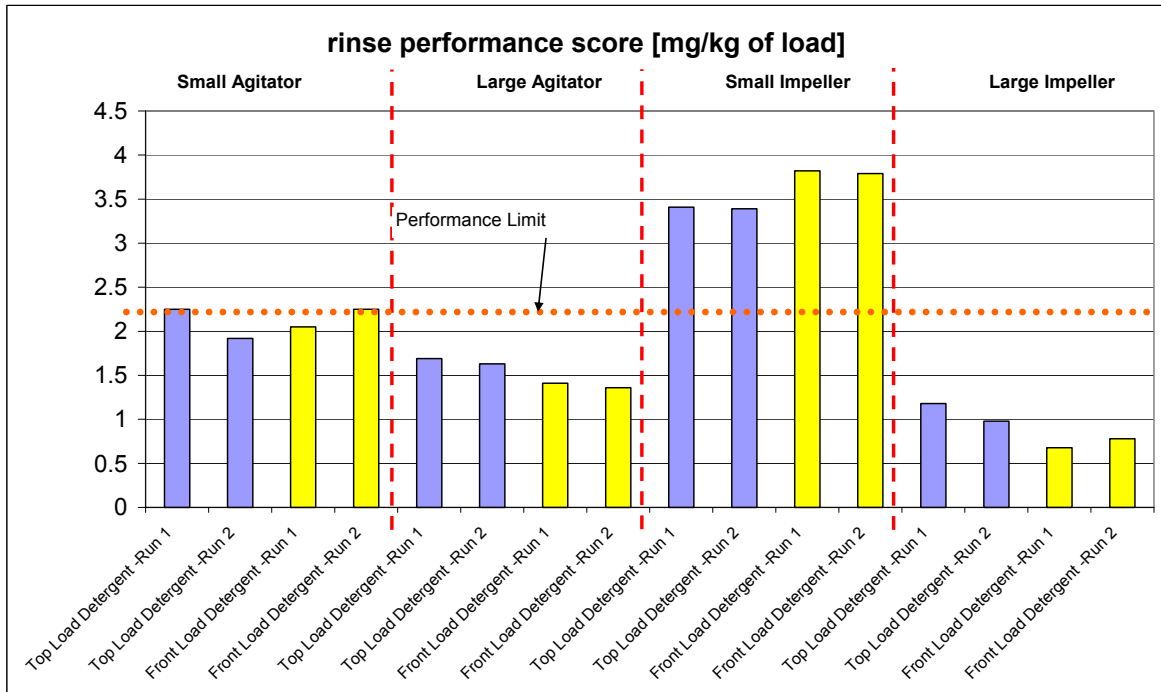
Table 38 : Rinse Performance Results – Overall analysis

Rinse Performance	All Runs	
	(mg/kg load)	%
Maximum Below AS/NZS	0.30	30.60
Maximum above AS/NZS	0.41	12.00



4.8.3 Results Graphical

Figure 20 : Rinse Performance Results – Individual Runs



4.8.4 Analysis

Compared to runs conducted using non drum detergent, runs conducted using drum detergent produced a range of differing performance results. Some machines produced worse rinse performance results (up to 0.41 higher) and some machines better results (up to 0.30 lower). On average the result was slightly improved (down 0.04).

4.8.5 Findings

Use of drum detergent appears to have no systematic impact on rinse performance results compared to those obtained using non drum detergent. Observed minor differences associated with particular machines appear to be a result of inherent variability associated with the particular test machine.



APPENDICIES



Appendix A- Project Specification

OBJECTIVE OF TESTING PROGRAM

This testing program is intended to provide comparative performance results for both top load (4 test samples) and front load (2 test samples) clothes washers using either the AS/NZS clothes load or the IEC clothes load. In addition, comparative performance results for top loaders (impeller type only¹) using either the current AS/NZS non drum detergent or the current AS/NZS drum type detergent (IEC type B) shall be determined.

These results shall be used by the EL 15/4 standards committee to help inform their decision regarding a proposed shift to the exclusive use of the IEC load and the IEC type B detergent for performance testing to AS/NZS 2040.1.

PROCESS OVERVIEW

Following is an outline in chronological order of the steps required to complete the works under this contract:-

Stage 1 – Repeatability testing under current AS/NZS Standard conditions (12 runs total)

- For each of the 6 clothes washers noted in the “Schedule of models to be tested” conduct 2 tests in accordance with AS/NZS 2040.1:2005 to determine the following:
 - Energy consumption (exclusive of standby)
 - Wash performance
 - Rinse Performance
 - Water consumption
 - Water extraction
 - Severity of washing action index
- Report the results of these tests to the project manager and await approval to proceed to stage 2 of the test program

Stage 2 – Comparative testing of IEC load (12 runs in total)

- For each of the 6 clothes washers noted in the “Schedule of models to be tested” conduct 2 tests in accordance with AS/NZS 2040.1:2005 but using a load as prescribed in IEC edition 4 to determine the following:
 - Energy consumption (exclusive of standby)
 - Wash performance
 - Rinse Performance
 - Water consumption
 - Water extraction
 - Severity of washing action index
- Report the results of these tests to the project manager and await approval to proceed to stage 3 of the test program



Stage 3 – Comparative testing of IEC type B detergent in top loader machines (8 runs in total)

- For each of the top load washers noted in the “Schedule of models to be tested” conduct 2 tests in accordance with AS/NZS 2040.1:2005 but using a load as prescribed in IEC edition 4 and IEC type B detergent dosed in accordance with the provisions of AS/NZS 2040.1:2005 to determine the following:
 - Energy consumption (exclusive of standby)
 - Wash performance
 - Rinse Performance
 - Water consumption
 - Water extraction
 - Severity of washing action index

Stage 4 – Final reporting and program finalisation

- Report the results of all stages of the test program to the project manager.
- When required, conduct additional tests of nominated products as deemed necessary by the Project Manager and convey these results to the Project Manager.
- Arrange for pick up of the test machines by the suppliers of those machines.

Supply of Clothes Loads

As noted in the above section tests will be conducted using 2 different types of load, the current AS/NZS load and the current IEC load. Test laboratories shall be expected to supply the AS/NZS load for the purposes of testing. The IEC loads shall be supplied by the principal who shall retain ownership of the load at the completion of the tests. A separate IEC load shall be supplied for each rated capacity claimed for the test units. At a minimum there will be 2 IEC loads supplied one “small” and one “medium”.

Note that test laboratories shall be responsible for the proper ageing of each of the test loads as per the IEC conditioning procedure.

TESTING DETAILS

- Bone dry mass requirements shall be met to within +/- 1/2 a towel.
- If anti foaming agent is to be used it shall be used on all runs.
- Recondition the loads to AS/NZS requirements.
- Attach the swatches to items in the AS/NZS fashion
- Where possible, attach the swatches to items matching those in AS/NZS. The fixing arrangements adopted should be documented.
- Follow the AS/NZS loading method and pattern



Appendix B- Details of load preparation

Prepared by Test Research Laboratories

1 Preparation of the IEC test load

- a. The test load was made up as described in Table 1 in the V4 Draft for Edition 5 of IEC60456. We used new load items purchased from wfk with “Pre-treatment” as per 60456 IEC:2003 clause 6.3.1.

Test load mass [kg]	Number of sheets	Number of pillow cases	Number of hand towels
5.5	2	8	20
8.0	3	12	28

- b. The number of hand towels was adjusted to make the test load as close as possible (± 60 g) to the BDM target for the load.

Load item		5.5 kg	8.0 kg
	BDM target		5.09 \pm 0.06 kg
		Number of swatches	Number of swatches
sheet		2	3
pillow case		8	12
hand towel		5	10

Bone Dry Mass was determined according to the method described in the AS/NZS2442.1:1996 Appendix E clause 2.5.

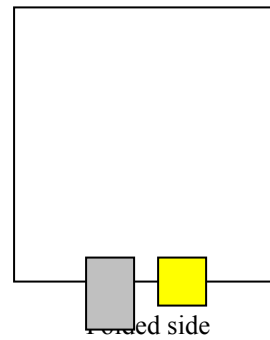


2 Attaching the AS9 switches to IEC load items

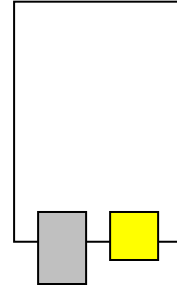
a. Bed sheet



b. Pillow case



c. Hand towel

**3 Picking up and folding IEC load items**

All items were picked up as per AS/NZS 2040.1:2005 Appendix C clause C4.1.1.

All items were folded as per AS/NZS 2040.1:2005 Appendix C clause C4.1.2

4 Loading IEC load items

All top loading machines (other than drum type) were loaded with bed sheets first followed by pillow cases and hand towels. The hand towels were loaded in a way so that those with the swatches were evenly distributed among those without. (See following diagrams).

All front loaders (drum type) were loaded to make sure that the load was balanced and evenly distributed.



Small Agitator IEC load



Large Agitator load



Small Impeller - IEC load



Large Impeller - IEC load

Appendix C- Data Sheets



Stage1 Tests

project number	D779	D779	D779	D779	D779	D779	D779	D779	D779	D779	D779	D779
test	stage 2	stage 2	stage 2	stage 2	stage 2	stage 2	stage 2	stage 2	stage 2	stage 2	stage 2	stage 2
Load Type	IEC	IEC	IEC	IEC	IEC	IEC	IEC	IEC	IEC	IEC	IEC	IEC
machine number	1	1	2	2	5	5	6	6	3	3	4	4
run number	1	2	1	2	1	2	1	2	1	2	1	2
type	agitator	agitator	agitator	agitator	Impeller	Impeller	Impeller	Impeller	Drum	Drum	Drum	Drum
date tested	27.7.2006	31/07/2006	31.7.2006	01.08.2006	25.7.2006	26.7.2006	26.7.2006	27.7.2006	01/08/2006	02/08/2006	02/08/2006	03/08/2006
capacity tested [kg]	5.5	5.5	8.0	8.0	5.5	5.5	8.0	8.0	5.5	5.5	8.0	8.0
load ID	5.5IEC	5.5IEC	8IEC	8IEC	5.5IEC	5.5IEC	8IEC	8IEC	5.5IEC	5.5IEC	8IEC	8IEC
BDM [kg]	5.110	5.110	7.458	7.458	5.128	5.128	7.405	7.405	5.088	5.088	7.433	7.433
detergent type	non-drum	non-drum	non-drum	non-drum	non-drum	non-drum	non-drum	non-drum	drum	drum	drum	drum
detergent amount [g]	104.5	104.5	152	152	104.5	104.5	152	152	68.8	68.8	100	100
PBIS [mg]	550	550	800	800	550	550	800	800	550	550	800	800
NaOH [mg]	90	90	132	132	90	90	132	132	90	90	132	132
water for detergent [L]	1.375	1.375	2.000	2.000	1.375	1.375	2.000	2.000	1.375	1.375	2.000	2.000
antifoam 10 [g]	10.2	10.1	10.2	10.1	10.1	10.1	10.0	10.3	10.2	10.2	10.2	10.2
cold water used [L]	59.4	58.7	98.1	97.4	35.9	36.5	143.6	144.0	68.3	69.4	64.1	65.0
hot water used [L]	19.6	19.2	35.4	35.2	30.2	30.5	34.0	33.4	0.0	0.0	0.0	0.0
total water used (incl detergent) [L]	80.4	79.3	135.5	134.6	67.5	68.4	179.6	179.4	69.7	70.8	66.1	67.0
electrical energy [kWh]	0.230	0.231	0.338	0.348	0.089	0.090	0.182	0.183	0.753	0.788	0.813	0.923
cold water energy [kWh]	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
hot water energy [kWh]	0.944	0.925	1.693	1.684	1.437	1.451	1.628	1.600	0.032	0.032	0.047	0.047
total energy [kWh]	1.174	1.156	2.031	2.032	1.526	1.541	1.810	1.783	0.785	0.820	0.860	0.970
PAEC	429	422	741	742	557	562	661	651	287	299	314	354
program time [min]	60	59	50	50	44	44	62	62	140	138	139	144
wet mass [kg]	8.763	8.828	13.474	13.593	9.067	9.048	13.093	13.102	8.835	8.939	11.827	11.868
WEI	0.715	0.728	0.807	0.823	0.768	0.764	0.768	0.769	0.736	0.757	0.591	0.597
normalized avg soil removal	89.0	87.60	78.1	85.4	83.9	85.2	82.2	84.8	87.20	88.10	88.80	88.30
SD	3.6	3.00	9.6	5.3	4.3	3.1	3.5	3.6	0.60	1.20	0.80	0.60
SR - 2 x SD	81.8	81.60	58.9	74.8	75.3	79.0	75.2	77.6	86.00	85.70	87.20	87.10
severity of washing action index	0.30	0.34	0.24	0.29	0.19	0.23	0.22	0.22	0.16	0.15	0.15	0.16
water supply [mg/L]	0.105	0.145	0.145	0.120	0.123	0.123	0.123	0.105	0.120	0.123	0.123	0.116
conditioned load liquor [mg/L]	-0.051	-0.059	-0.040	-0.044	0.018	0.003	0.036	-0.051	-0.059	-0.029	-0.040	0.011
rinse liquor [mg/L]	3.38	2.838	2.245	2.128	4.763	4.752	1.652	1.372	1.863	1.688	3.988	4.010
rinse performance score [mg/kg of load]	2.245	1.918	1.688	1.632	3.411	3.387	1.175	0.977	1.269	1.182	2.190	2.223
Star Rating Index	2.22	2.24	1.71	1.69	1.52	1.5	2.02	2.06	3.11	3	3.95	3.68



Stage2 Tests

project number	D779	D779	D779	D779	D779	D779	D779	D779	D779	D779	D779	D779
test	stage 2	stage 2	stage 2	stage 2	stage 2	stage 2	stage 2	stage 2	stage 2	stage 2	stage 2	stage 2
Load Type	IEC	IEC	IEC	IEC	IEC	IEC	IEC	IEC	IEC	IEC	IEC	IEC
machine number	1	1	2	2	5	5	6	6	3	3	4	4
run number	1	2	1	2	1	2	1	2	1	2	1	2
type	agitator	agitator	agitator	agitator	Impeller	Impeller	Impeller	Impeller	Drum	Drum	Drum	Drum
date tested	27.7.2006	31/07/2006	31.7.2006	01.08.2006	25.7.2006	26.7.2006	26.7.2006	27.7.2006	01/08/2006	02/08/2006	02/08/2006	03/08/2006
capacity tested [kg]	5.5	5.5	8.0	8.0	5.5	5.5	8.0	8.0	5.5	5.5	8.0	8.0
load ID	5.5IEC	5.5IEC	8IEC	8IEC	5.5IEC	5.5IEC	8IEC	8IEC	5.5IEC	5.5IEC	8IEC	8IEC
BDM [kg]	5.110	5.110	7.458	7.458	5.128	5.128	7.405	7.405	5.088	5.088	7.433	7.433
detergent type	non-drum	non-drum	non-drum	non-drum	non-drum	non-drum	non-drum	non-drum	drum	drum	drum	drum
detergent amount [g]	104.5	104.5	152	152	104.5	104.5	152	152	68.8	68.8	100	100
PBIS [mg]	550	550	800	800	550	550	800	800	550	550	800	800
NaOH [mg]	90	90	132	132	90	90	132	132	90	90	132	132
water for detergent [L]	1.375	1.375	2.000	2.000	1.375	1.375	2.000	2.000	1.375	1.375	2.000	2.000
antifoam 10 [g]	10.2	10.1	10.2	10.1	10.1	10.1	10.0	10.3	10.2	10.2	10.2	10.2
cold water used [L]	59.4	58.7	98.1	97.4	35.9	36.5	143.6	144.0	68.3	69.4	64.1	65.0
hot water used [L]	19.6	19.2	35.4	35.2	30.2	30.5	34.0	33.4	0.0	0.0	0.0	0.0
total water used (incl detergent) [L]	80.4	79.3	135.5	134.6	67.5	68.4	179.6	179.4	69.7	70.8	66.1	67.0
electrical energy [kWh]	0.230	0.231	0.338	0.348	0.089	0.090	0.182	0.183	0.753	0.788	0.813	0.923
cold water energy [kWh]	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
hot water energy [kWh]	0.944	0.925	1.693	1.684	1.437	1.451	1.628	1.600	0.032	0.032	0.047	0.047
total energy [kWh]	1.174	1.156	2.031	2.032	1.526	1.541	1.810	1.783	0.785	0.820	0.860	0.970
PAEC	429	422	741	742	557	562	661	651	287	299	314	354
program time [min]	60	59	50	50	44	44	62	62	140	138	139	144
wet mass [kg]	8.763	8.828	13.474	13.593	9.067	9.048	13.093	13.102	8.835	8.939	11.827	11.868
WEI	0.715	0.728	0.807	0.823	0.768	0.764	0.768	0.769	0.736	0.757	0.591	0.597
normalized avg soil removal	89.0	87.60	78.1	85.4	83.9	85.2	82.2	84.8	87.20	88.10	88.80	88.30
SD	3.6	3.00	9.6	5.3	4.3	3.1	3.5	3.6	0.60	1.20	0.80	0.60
SR - 2 x SD	81.8	81.60	58.9	74.8	75.3	79.0	75.2	77.6	86.00	85.70	87.20	87.10
severity of washing action index	0.30	0.34	0.24	0.29	0.19	0.23	0.22	0.22	0.16	0.15	0.15	0.16
water supply [mg/L]	0.105	0.145	0.145	0.120	0.123	0.123	0.123	0.105	0.120	0.123	0.123	0.116
conditioned load liquor [mg/L]	-0.051	-0.059	-0.040	-0.044	0.018	0.003	0.036	-0.051	-0.059	-0.029	-0.040	0.011
rinse liquor [mg/L]	3.38	2.838	2.245	2.128	4.763	4.752	1.652	1.372	1.863	1.688	3.988	4.010
rinse performance score [mg/kg of load]	2.245	1.918	1.688	1.632	3.411	3.387	1.175	0.977	1.269	1.182	2.190	2.223
Star Rating Index	2.22	2.24	1.71	1.69	1.52	1.5	2.02	2.06	3.11	3	3.95	3.68



Stage3 Tests

project number	D779	D779	D779	D779	D779	D779	D779	D779
test	stage 3	stage 3	stage 3	stage 3	stage 3	stage 3	stage 3	stage 3
Load Type	IEC	IEC	IEC	IEC	IEC	IEC	IEC	IEC
machine number	1	1	2	2	5	5	6	6
run number	1	2	2	3	1	2	1	2
type	agitator	agitator	agitator	agitator	Impeller	Impeller	Impeller	Impeller
date tested	08/08/2006	09/08/2006	9.8.2006	10.8.2006	10/08/2006	11.08.2006	11.08.2006	14.08.2006
capacity tested [kg]	5.5	5.5	8.0	8.0	5.5	5.5	8.0	8.0
load ID	5.5IEC	5.5IEC	8IEC	8IEC	5.5IEC	5.5IEC	8IEC	8IEC
BDM [kg]	5.075	5.075	7.417	7.403	5.060	5.060	7.403	7.388
detergent type	drum	drum	drum	drum	drum	drum	drum	drum
detergent amount [g]	68.8	68.8	100	100	68.8	68.8	100	100
PBIS [mg]	550	550	800	800	550	550	800	800
NaOH [mg]	90	90	132	132	90	90	132	132
water for detergent [L]	1.375	1.375	2.000	2.000	1.375	1.375	2.000	2.000
antifoam 10 [g]	10.1	10.3	10.2	10.0	10.3	10.1	10.0	10.1
cold water used [L]	59.1	57.1	97.1	98.4	36.5	36.4	149.5	148.6
hot water used [L]	19.6	19.9	35.2	35.3	30.3	30.1	30.2	29.6
total water used (incl detergent) [L]	80.1	78.4	134.3	135.7	68.2	67.9	181.7	180.2
electrical energy [kWh]	0.230	0.235	0.361	0.359	0.089	0.089	0.182	0.185
cold water energy [kWh]	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
hot water energy [kWh]	0.944	0.958	1.684	1.688	1.441	1.432	1.451	1.423
total energy [kWh]	1.174	1.193	2.045	2.047	1.530	1.521	1.633	1.608
PAEC	428.510	435.445	746.425	747.155	558.450	555.165	596.045	586.920
Program time [min]	60	59	50	49	44	43	62	62
wet mass [kg]	8.722	8.748	13.623	13.694	9.14	9.178	13.43	13.399
WEI	0.719	0.724	0.837	0.85	0.806	0.814	0.814	0.814
normalized avg soil removal	88.3	85.9	73.3	79.7	87.1	87.9	84.2	85.2
SD	4.8	2.7	12.6	9.8	1.4	1.4	3.1	2.5
SR - 2 x SD	78.7	80.5	48.1	60.1	84.3	85.1	78.0	80.2
severity of washing action index	0.32	0.34	0.19	0.23	0.24	0.23	0.22	0.23
water supply [mg/L]	0.127	0.127	0.127	0.123	0.123	0.134	0.134	0.127
conditioned load liquor [mg/L]	-0.026	-0.040	-0.070	-0.033	-0.022	-0.004	0.029	-0.055
rinse liquor [mg/L]	3.086	3.373	1.823	1.728	5.149	5.065	0.898	1.037
rinse performance score [mg/kg of load]	2.046	2.253	1.414	1.359	3.82	3.792	0.677	0.779
Star Rating Index	2.21	2.17	1.66	1.65	1.48	1.49	2.22	2.26

