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Zheshartsky LPK Ltd.
Shkolnaya Str. 1
427551 Balezinsky district
Russia

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Braunschweig, 21 December 2021

Test report No. QA-2021-3163

Client: Zheshartsky LPK Ltd.
Shkolnaya Str. 1
427551 Balezinsky district (Russia)

Product name: Russian Birch Plywood
Supervision contract number: certification number 1425

Objective of the test: Evaluation of correlation in reference to the Final Regulation Order of
"Airborne Toxic Control Measure to Reduce Formaldehyde Emission from
Composite Wood Products", 93120-93120.12, title 17,
California Code of Regulations, § 93120

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The test report comprises 7 pages, 5 tables and 1 figure.

This test report is not permitted to be published incompletely.

A publication in extracts is in any case subject to the previous consent of Fraunhofer Institute for Wood Research, Wilhelm-Klauditz-Institut WKI, Bienroder Weg 54E in 38108 Braunschweig (Germany). The test results exclusively refer to the objects of the test. The test material was used up.



CARB notified TPC 4



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1. Task

The Fraunhofer Institute for Wood Research, Wilhelm-Klauditz-Institut WKI, was assigned by Messrs. Zheshartsky LPK Ltd. in 427551 Balezinsky district (Russia) to carry out the inspection and determine by measurements the formaldehyde emission potential of wood-based panels according to the requirements published by California Air Resources Board (CARB) referring to the Final Regulation Order of "Airborne Toxic Control Measure to Reduce Formaldehyde Emission from Composite Wood Products", 93120-93120.12, title 17, California Code of Regulations, § 93120.

The Fraunhofer WKI is approved as third party certifier based on the executive order number W-20-004 issued by the State of California Air Resource Board (CARB).

As mentioned in § 93120.9 (a)(3)(C)(d) a Quality control method can be used if a correlation has been shown either to the primary or secondary methods for performing routine quality control tests as required by section 93120.3. A correlation must be established between the quality control test method and the primary, secondary, or alternate secondary test method. The correlation is based on a minimum sample size of five data pairs (Appendix 2 (f)(2)).

The required correlation shall be established based on the test results of chamber method ASTM D 6007 "Determining Formaldehyde Concentration in Air from Wood Products Using a Small Scale Chamber" as reference test method done in the TPC laboratory and the factory production control (FPC) method used as quality control test method in the manufacturer's laboratory.

A supervision contract with certification number 1425 is in force.

2. Test methods

2.1. Secondary test method ASTM D 6007

Referring to § 93120.9 (a)(2) a secondary method, defined as specified in ASTM D 6007 "Determining Formaldehyde Concentration in Air from Wood Products Using a Small Scale Chamber" can be used to determine formaldehyde release as secondary test method subsequent showing equivalence to ASTM E 1333 "Determining Formaldehyde Concentration in Air and Emission Rates from Wood Products Using a Large Chamber" according to § 93120.9 (a)(B).

Equivalence has been shown and established between the American standard ASTM E 1333 "Determining Formaldehyde Concentration in Air and Emission Rates from Wood Products Using a Large Chamber" and ASTM D 6007 "Determining Formaldehyde Concentration in Air from Wood Products Using a Small Scale Chamber" according to § 93120.9 (a)(B). Therefore, the small chamber test method as specified in ASTM D 6007 can be used for quality control testing.

2.2 Quality control test method

The determination of formaldehyde release or content was carried out according to CARB approved factory production control (FPC) methods.

The manufacturer used the following method for factory production control:

<input type="checkbox"/>	ASTM D 6007-14
<input type="checkbox"/>	DMC User's Manual
<input checked="" type="checkbox"/>	EN ISO 12460-3:2015 E (Gas Analysis Method)
<input type="checkbox"/>	EN ISO 12460-5:2015 E (Perforator Method)
<input type="checkbox"/>	JIS A 1460:2015 (E) (24-hr Desiccator Method)

The determination of formaldehyde release or content was done for samples in the manufacturer's laboratory within a defined period after production as mentioned in the manufacturer's quality control manual.

The FPC test results determined were reported to Fraunhofer WKI.

3. Test material

Product:	plywood, uncoated
Product name:	Russian Birch Plywood
Plant:	Zheshartsky LPK Ltd. in 427551 Balezinsky district (Russia)
Thickness range certified [mm]:	$3 \leq 30$
Thickness range tested [mm]:	$6 \leq 30$

4. Assessment of results

4.1. ASTM chamber test results

The limit values according to the requirements of the Final Regulation Order of "Airborne Toxic Control Measure to Reduce Formaldehyde Emission from Composite Wood Products", 93120-93120.12, title 17, California Code of Regulations, § 93120.2 (a) "Formaldehyde Emission Standards for Hardwood Plywood (HWPW), Particleboard (PB), and Medium Density Fiberboard (MDF)" are listed in table 1.

All tested samples comply with the requirements of limit values.

4.2. Correlation data

For evaluation of correlation data, following the test results of samples tested are used in reference to

<input checked="" type="checkbox"/>	initial correlation CARB/TSCA
<input type="checkbox"/>	quarterly inspection(s) CARB/TSCA
<input type="checkbox"/>	additional sample material requested by Fraunhofer WKI
<input type="checkbox"/>	samples for verification of correlation in case of production amendments or new grouping:
<input type="checkbox"/>	new glue supplier / same glue type
<input type="checkbox"/>	change of resin formulation (increase of formaldehyde to urea ratio $\geq 10\%$)
<input type="checkbox"/>	decrease of designated press time $> 20\%$
<input type="checkbox"/>	other:

The samples for initial correlation, additional test material or verification tests were selected by the customer corresponding to Fraunhofer WKI's guidelines, samples of quarterly inspection were chosen on random by an Fraunhofer WKI inspector.

All samples were marked, sent to the Fraunhofer WKI for examination. The samples arrived packed separately in polyethylene plastic foil and stored under room conditions. The corresponding test reports are mentioned in table 2. The test results determined for chamber tests according to ASTM D 6007 done in Fraunhofer WKI's laboratory and FPC test results reported by the manufacturer are listed in table 3.

4.3. Evaluation of correlation

For calculation of correlation CARB guideline CWP-10-001: "Third Party Certification Guideline: Establishing a Correlation With an Acceptable Correlation Coefficient ("r", Value)" dated June 8, 2010 was considered. Referring to CARB three options can be used to establish a correlation:

Data mentioned in para 4.2. are used for calculation and summarized in table 3. In order to keep the correlation up to date with the current state of production, a maximum of not more than 12 data pairs (last 3 years for data of initial and/or quarterly inspections) are used for the calculation of correlation.

For calculation of correlation according to CARB guideline three different approaches can be considered:

Option	1 – linear regression	2 – cluster approach	3 – threshold value
Chamber test results	difference of results $\geq 0,05$ ppm	similar test results resp. grouping (cluster) of data pairs	similar test results resp. grouping (cluster) of data pairs
Calculation of correlation	linear regression	linear regression using an anchor point ¹⁾	preliminary threshold value; basis: average value of reported FPC test results

Based on these approaches, the correlation was calculated considering the variation of ASTM chamber results and the normal distribution of data for different levels:

Level 1: data pairs with sufficient variation of chamber results

Level 2: data pairs with variation or clustering of chamber results and additional data pair

Level 3: data pairs with variation or clustering of chamber results by using an "anchor point"

The QCL was calculated by considering the correlation with best validated r-value of selectable data pairs.

4.3.1. Correlation calculated using linear regression

In general, all data available were checked concerning their normal distribution. For this statistical hypothesis testing, the Shapiro-Wilk test was used.

In case of a normal distribution of data, the calculation of correlation was done according to Pearson, for non-normal distributed data Spearman was used. The graphic analysis by MS Excel was not considered, in lieu thereof the mathematically exact derivatives of the individual steps for the respective statistics models are calculated.

The correlation coefficient (R^2) of a linear regression expresses how much the straight line considers the measuring points and was calculated as "r value" to show compliance with CARB guideline CWP-10-001.

4.3.2. Cluster approach

The correlation was calculated by using a point near to the origin considering values for untreated wood/wood particles and a chamber value lower than the blank value (zero; origin). For data pairs showing this grouping (cluster) of data, an additional data pair was used by assumed as either an additional data pair or as anchor point for the calculation of the correlation the value of untreated wood / wood particles ¹⁾.

Accordingly, a value less than the blank value was assumed for the chamber method and the following equivalent values for the derived test methods:

- ASTM chamber / DMC: 0.0 ppm
- gas analysis method: 0.0 mg/h.m²
- perforator method: 0.3 mg/100 g oven-dry material
- desiccator method: 0.0 mg/L

Due to the regression is artificially steered through the "anchor point", the correlation coefficient has to be corrected by a penalty term for this theoretical data point. The correlation coefficient R^2_{adj} (adjusted) is also described as an "uncentered" coefficient of determination and calculated as follows:

$$R^2_{adj} = 1 - (1 - R^2) \cdot \frac{n - 1}{n - p - 1}$$

Where is:

R^2_{adj} : correlation coefficient calculated with penalty term

R^2 : calculated correlation coefficient of linear regression

n : number of data pairs

p : smallest level of significance at which the null hypothesis would be rejected (here: 5%; 0.05)

The quality of the regression with anchor point is verified by using the F-statistic at $\alpha = 0.05$ significance level.

¹⁾ referring to thesis "The formaldehyde release of wood and changes during technical processes of wood-based panels production", Christian Boehme, published by Shaker Verlag, Aachen 2000, Register D7 (Diss. University Göttingen, Germany)

4.3.3. Threshold value

A third option is to use a threshold approach in which the average small-scale test value, calculated as above from a data cluster, is used as the Quality Control Limit (QCL) for the product. This value would be a “do not exceed” limit for the product that provides a margin of safety relative to the maximum value in the data cluster.

4.3.4. Correlation data

The correlation diagram and level used is shown in figure 1. The correlation data and calculated factory production control (FPC) limit value to comply with CARB (P2) requirements is mentioned in table 4.

Referring to CARB guideline CWP-10-001 dated June 8, 2010 the minimum acceptable correlation coefficient for a correlation corresponding to the number of evaluated data pairs have 3-degrees of freedom and must achieve an r-value as mentioned in table 5.

5. Definition and calculation of limit values

5.1. Quality Control Limit (QCL)

The quality control limit of each product type is the correlative equivalent of the maximum value allowed by large chamber tests referring to the requirements of CARB. The samples can be taken at any time after the hot press and before shipment. The test date resp. sampling has to be fixed by the manufacturer. Therefore, the quality control limit value (QCL) has to be calculated by taking in consideration the results of test method used for internal factory production control (FPC) and ASTM chamber data of Fraunhofer WKI results as mentioned below (table 4).

5.2. Excursion Limit Value

The excursion limit value is a quality control level (QCL) that shall not be exceeded by a certified lot. This limit value is designed to that when 95% of all tests fall below QCL, 99.9% of all values will be below the excursion limit.

To calculate the excursion limit value the manufacturer has to carry out at least 20 up to 100 tests by using the factory production control test method and calculate the standard deviation (SD) first. The minimally acceptable correlation coefficients are given in EN 326-2. This has to be done twice a year.

This level is established at 1.35 times of the standard deviation above the QCL (Excursion limit = $QCL + 1.35SD$).

5.3. Target Operating Level (TOL)

To reasonably assure that at least 95% of the factory production values (FPC) are at or below the QCL, the average value of FPC should be at the QCL less a specific value "X" ($TOL = QCL - X$). This specific value "X" has to be determined by measuring the recent trends of i.e. 30 tests of FPC and comparing them to QCL taking the variability in account. As variability for a normal distribution a standard deviation of 1.65 can be used. Each plant should use its own data to develop a factor "X", such as calculate $TOL = QCL - XSD$. This provides an adequate warning that a risk exists of exceeding the QCL by more than 5% of FPC tests. Thus, a TOL of 2 times SD below QCL would provide greater safety margin and has to be fixed by the manufacturer.

5.4. Shipping Quality Control Limit Value (SQCL)

The SQCL is based upon the correlation between the FPC test method of a product ready for shipment and the large chamber tests. Depending on the shipment data fixed by the manufacturer it can be differ or be the same as QCL. Typically, a running of 30 panel average is calculated and compared to a predetermined operating level by the manufacturer. The SQCL is used for determining conformance of a non-complying lot.

6. Evaluation

The correlation has been calculated and evaluated as follows:

Correlation data evaluated based on requirement of	period	QCL calculated for ASTM D 6007 vs. Manufacturer FPC results	Correlation complies with minimum r value of CARB guideline CWP-10-001
CARB	Q4/2021	<input checked="" type="checkbox"/> yes <input type="checkbox"/> no	<input checked="" type="checkbox"/> yes <input type="checkbox"/> no

On the basis of the correlation tests, considering production variability as well as method-related variances of the derived test methods used, the manufacturer must calculate tolerances that ensure that the calculated product-specific limit value (QCL) is adhered to when the product enters the market.



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Officer in charge




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Head of Testing, Supervision and
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Table 1: Final Regulation Order of “Airborne Toxic Control Measure to Reduce Formaldehyde Emission from Composite Wood Products”, 93120-93120.12, title 17, California Code of Regulations, § 93120.2 (a), emission standards, according to table 1: “Phase 1 and Phase 2 formaldehyde emission standards for hardwood plywood (HWPW), particleboard (PB) and medium density fibreboard (MDF)¹⁾”

- Phase 1 (P1) and Phase 2 (P2) Emission Standards (ppm) –						
Effective Date		HWPW-VC	HWPW-CC	PB	MDF	Thin MDF
1 January	2009	P1: 0.08	-	P1: 0.18	P1: 0.21	P1: 0.21
1 July	2009	-	P1: 0.08	-	-	-
1 January	2010	P2: 0.05	-	-	-	-
1 January	2011	-	-	P2: 0.09	P2: 0.11	-
1 January	2012	-	-	-	-	P2: 0.13
1 July	2012	-	P2: 0.05	-	-	-

⁽¹⁾ Based on the primary test method ASTM E 1333 in parts per million (ppm)

HWPW-VC: veneer core; HWPW-CC: composite core

Table 2: Considered test reports used for evaluation of correlation data

Product: plywood, uncoated
 Product name: Russian Birch Plywood
 Plant: Zheshartsky LPK Ltd. in
 427551 Balezinsky district (Russia)
 Thickness range certified [mm]: $3 \leq 30$
 Thickness range tested [mm]: $6 \leq 30$

Year	Quarter	Sample-ID. No.	Sample-ID. No.	Thickness [mm]	Test report No.		Date of test report [YYYY-MM-DD]
		quarterly inspection*	additional tests**		related to CARB supervision	related to TSCA supervision	
2021	4		6286	15	QA-2021- 3153	3154	2021-12-21
2021	4		6287	25	QA-2021- 3155	3156	2021-12-21
2021	4		6288	30	QA-2021- 3157	3158	2021-12-21
2021	4		5685	6	QA-2021- 3159	3160	2021-12-21
2021	4		5686	12	QA-2021- 3161	3162	2021-12-21

* test material was selected on random by an Fraunhofer WKI inspector during quarterly inspection

** test material was selected by the customer corresponding to Fraunhofer WKI's guidelines

Table 3: Summary - formaldehyde determination – Test methods and results

Test method TPC laboratory: ASTM D 6007

Test method manufacturer laboratory:

<input type="checkbox"/>	ASTM D 6007
<input type="checkbox"/>	DMC User's Manual
<input checked="" type="checkbox"/>	EN ISO 12460-3 (Gas Analysis Method)
<input type="checkbox"/>	EN ISO 12460-5 (Perforator Method)
<input type="checkbox"/>	JIS A 1460 (Desiccator Method)

Period of FPC test:

<input checked="" type="checkbox"/>	FPC tests at the time specified in the manufacturer's quality control manual
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Year	Quarter	Test carried out by			Fraunhofer WKI		Manufacturer	
		Sample-ID. No. quarterly inspection*	Sample-ID. No. additional tests**	Production date [YYYY-MM-DD]	Test date [YYYY-MM-DD]	Chamber test ASTM D 6007*** [ppm]	Test date [YYYY-MM-DD]	FPC test results [mg/m ² h]
2021	4		6286	2021-11-10	2021-11-26	0.015	2021-11-15	0.4
2021	4		6287	2021-11-10	2021-11-26	0.018	2021-11-17	0.7
2021	4		6288	2021-11-10	2021-11-26	0.014	2011-11-24	0.4
2021	4		5685	2021-11-10	2021-12-14	0.035	2021-11-16	0.5
2021	4		5686	2021-11-10	2021-12-14	0.013	2021-11-17	0.3

* test material was selected on random by an Fraunhofer WKI inspector during quarterly inspection
 ** test material was selected by the customer corresponding to WKI's guidelines
 *** test results calculated to 3 decimal places
 N/A: not reported

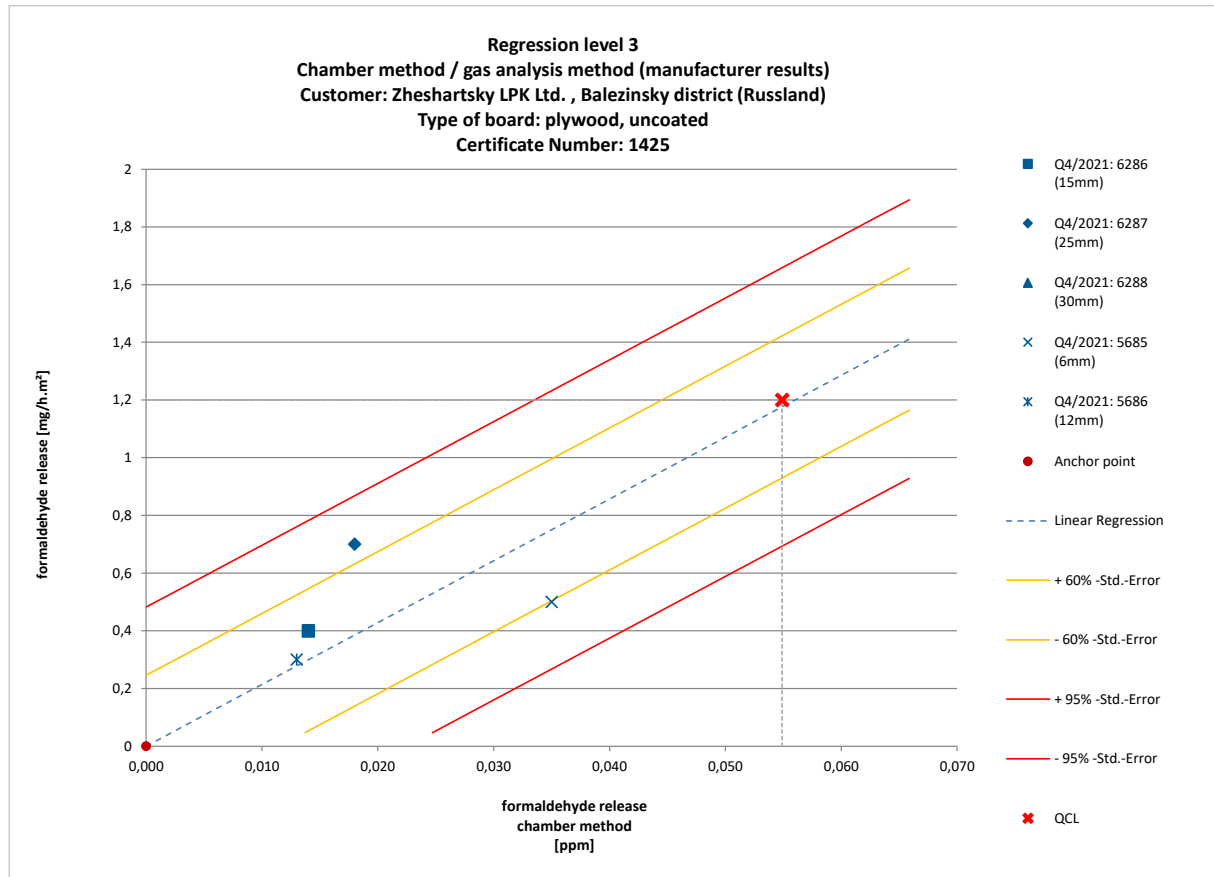


Figure 1: Correlation of chamber test results according to ASTM D 6007 (TPC laboratory) versus Factory production control (FPC) method (manufacturer's laboratory)

Test method manufacturer laboratory:	□	ASTM D 6007
	□	DMC User's Manual
	x	EN ISO 12460-3 (Gas Analysis Method)
	□	EN ISO 12460-5 (Perforator Method)
	□	JIS A 1460 (Desiccator Method)

based on FPC tests carried out at the time specified in the manufacturer's quality control manual

Table 4: Calculated quality control limit value (QCL) based on correlation factor determined for immediate FPC tests carried out at the time specified in the manufacturer's quality control manual

Product: plywood, uncoated
 Product name: Russian Birch Plywood
 Plant: Zheshartsky LPK Ltd. in
 427551 Balezinsky district (Russia)
 Thickness range certified [mm]: $3 \leq 30$
 Thickness range tested [mm]: $6 \leq 30$

Option used to establish the correlation and calculation of QCL or fixed threshold value without correlation (see chapter 4.2):

- Option 1
 Option 2
 Option 3
- large variance of test results e.g. due very low emitting product; additional data pairs of quarterly inspections have to be included

Quality Control Limit (QCL) was established for the certified thickness range (allowable tolerances: minimum +2 mm; maximum -2 mm)

- yes particleboard, plywood, MDF
 yes thin MDF (≤ 8 mm) by considering the technical feasibility
 no QCL is valid for 3 months (related to issue date of the report) subject to additional tests to verify the certified thickness range

Correlation based on the manufacturer's factory production control (FPC) values determined by	Correlation data*						Quality Control Limit (QCL) based on Manufacturer FPC method	
	Number of Data pairs	Factor	R ² -adj. F-Statistic a=0.05 Significant	r-value	min. r-value accepted*	intercept of y-axis**		
EN ISO 12460-3 (Gas Analysis Method)	5	21.32	0.8453	0.9194	0.878	0.0	1.2	mg/m²h

* Referring to CARB guideline CWP-10-001 dated June 8, 2010 the minimum acceptable correlation coefficient for a correlation based on the evaluated data pairs have 3-degrees of freedom and must achieve an r-value as mentioned in table 5

** see chapter 4

Table 5: Establishing a Correlation With an Acceptable Correlation Coefficient ("r", Value) referring to CARB guideline CWP-10-001 dated June 8, 2010

Minimum "r" values for Certified Mill Product Correlations ¹	
Degrees of Freedom (n-2) ²	"r" value
3	0.878
4	0.811
5	0.754
6	0.707
7	0.666
8	0.632
9	0.602
10 or more	0.576

⁽¹⁾ From: The British Standards Institution. 2000. Wood-based panels. Sampling, cutting and inspection. Quality control in the factory. BS EN 326-2. 36 pp.

⁽²⁾ "n" = number of primary/secondary and small-scale test data pairs. Correlations based on five data pairs have 3-degrees of freedom and must achieve an "r" value of 0.878 or greater.