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Engineering Calculations

Referring Project
Mission
Project-number
080-JOC18-09

Prepared for: Jockimo Inc. projects

Table of Content:

1 General

The glass floor panels are manufactured by “Jockimo Inc. projects”, UL approved in accordance with UL 410, the US standard for the slip resistance of floor surface materials.

Address of the Manufacturer: Jockimo Inc. projects
20101 SW Birch, Suite #276
Newport Beach, CA 92660

This report is about the glass panels only.

1.1 Project documents from the client

Submitted by mail on 14th July 2009:

1 panel:

3/8" top layer – Clear tempered UL Approved Jockimo GlassGrit™ texture
.060 inter layer
3/8" middle layer – Clear tempered
.060 inter layer
3/8" bottom layer – Clear tempered

1.2 Safety concept

Due to the specific features of glass the plates are built from three layers of glass sheets.
The loads are applied to two layers only, assuming that one sheet might break.
In the serviceability state, which shows the deflections, all sheets are considered.

2 Description of the construction

2.1 General

The considered glass panel (floor panel 52-3/4” x 48” with cutout 6-1/4” x 3-3/4”) is supported on four sides by a steel angle.

2.2 Glass build-up

Number of layers:	3 pieces

Build-up	Thickness	Material
Upper layer:	3/8’’	tempered
Inter-layer:	0.06’’	Liquid lamination
Middle layer:	3/8’’	tempered
Inter-layer:	0.06’’	Liquid lamination
Bottom layer:	3/8’’	tempered

2.3 Geometry

Size of the panel: 52-3/4” x 48”

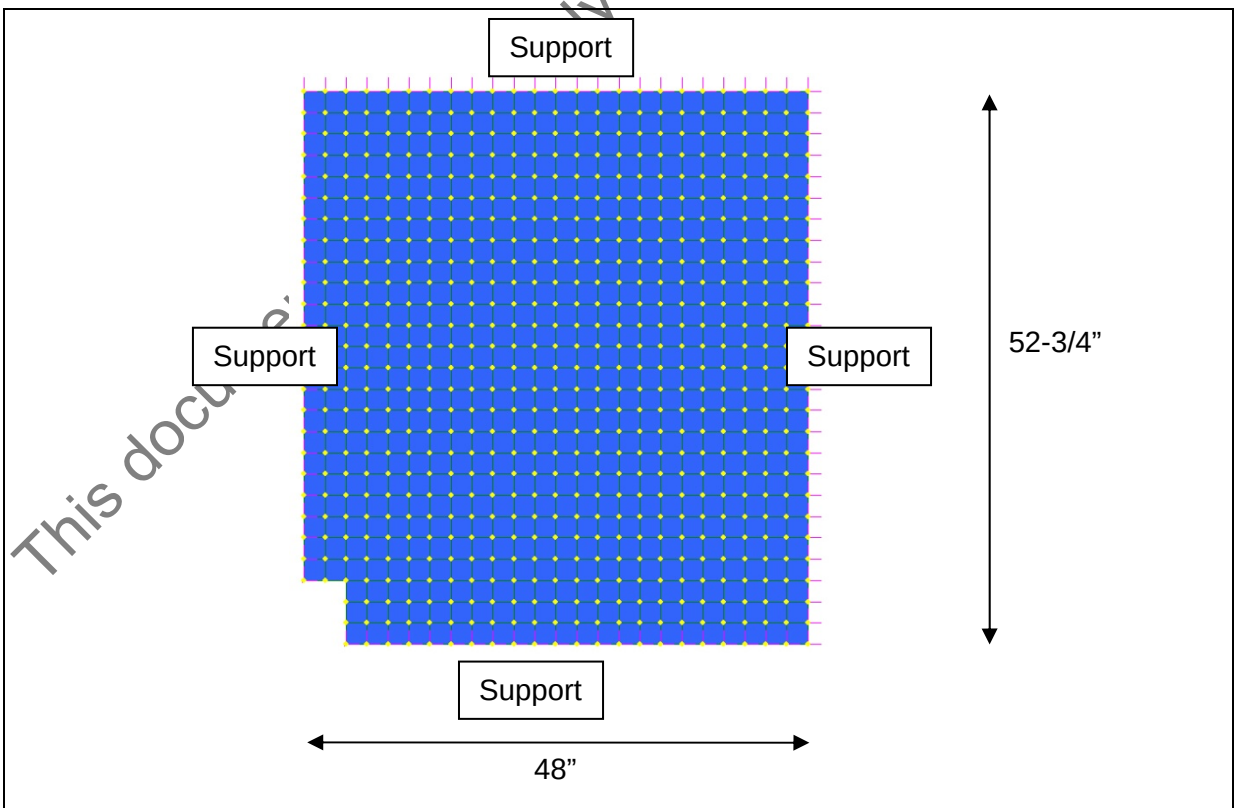

Figure 1: Geometry

2.4 Bearing conditions

The panel is supported on the considered sides in vertical direction.
It is assumed that the entire construction is stable without any strength of the glass.
The neoprene layer should have a width of at least 1” and a thickness of 0.1”. The support structure is made by others.

2.5 General notes

The position of the glass sheets is to be fixed against uplift in the corners, either by mechanical fixing or splicing to the support.

3 Material properties

3.1 Glass

- Young's Modulus = 10,400,000 psi
- Poisson Ratio = 0.22
- Allowable edge stress per ASTM E1300 :
  - Load duration 10 years

Allowable Design Stress of Glass acc. to GANA & ASTM E1300-04 (Appendix X8 & X9)

Glass type: FT FT = Fully tempered, HS = Heat Strengthened, A = Annealed

Glass Slope: 0 Degrees from horizontal (input is limited from 0º to 90º)

load duration (d): 3,15E+08 seconds

Data from Table 6 of Gana Manual:

	A	HS	FT	
Breakage 1/1,000	1900	4700	10200	psi, due to 60 second load duration.
Breakage 8/1,000	2800	5600	11200	

For overhead glazing (Slope < 75°), design values with probability of breakage of 1 lite in 1,000 will be used. For vertical glazing (Slope ≥ 75°), design values with probability of breakage of 8 lites per 1,000 will be used.

Design equation: $\sigma_{all} = \sigma_{60}\left(\frac{60\,\text{sec}}{d}\right)^{1/16}$

Where: σ_{60}= appropriate stress from values above d=load duration for current application (in days or seconds)

Allowable design stress= **3878** **psi**

Table 1: Allowable design stress of glass according GANA & ASTM with a load duration of 10 years

3.2 Neoprene

- Young's Modulus = 400 psi (short term load, room temperature)
- Poisson Ratio = 0.45
- Shore hardness = 50

4 Loads

4.1 Dead Load – LC1

Material	Unit weight [pcf]	Note
Glass	159.25	The loads are considered automatically by the computer program

4.2 Live Load – LC2, LC3

The critical load cases are given below. They are based on the requirements in the ASCE Tab.4-1 and the IBC, Table 1607.1.

Load case	Description	Load
2	Uniformly distributed live load	100 psf 100/12²= 0.70 psi
3	Concentrated live load	300 lb on area of 4 sqin 300/4= 75 psi

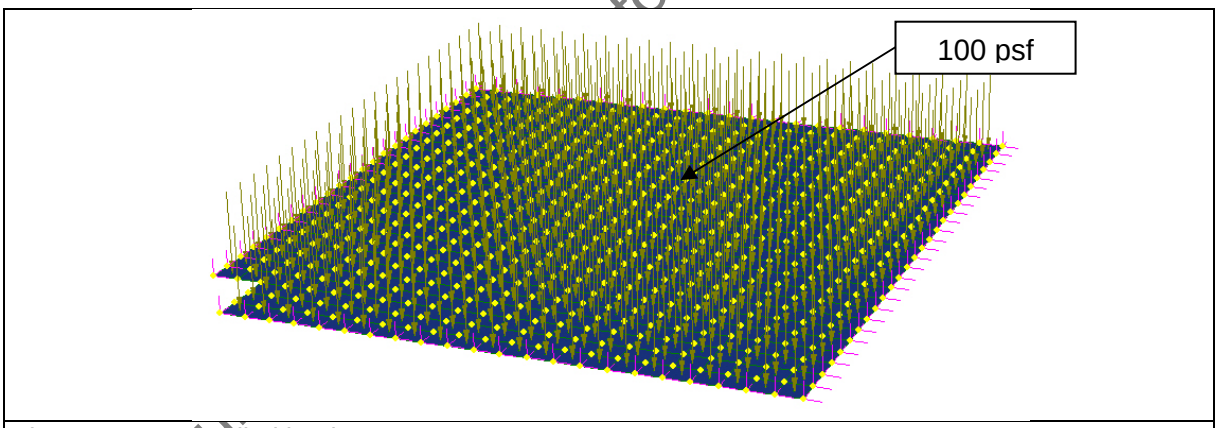

Figure 2: LC2: Applied load

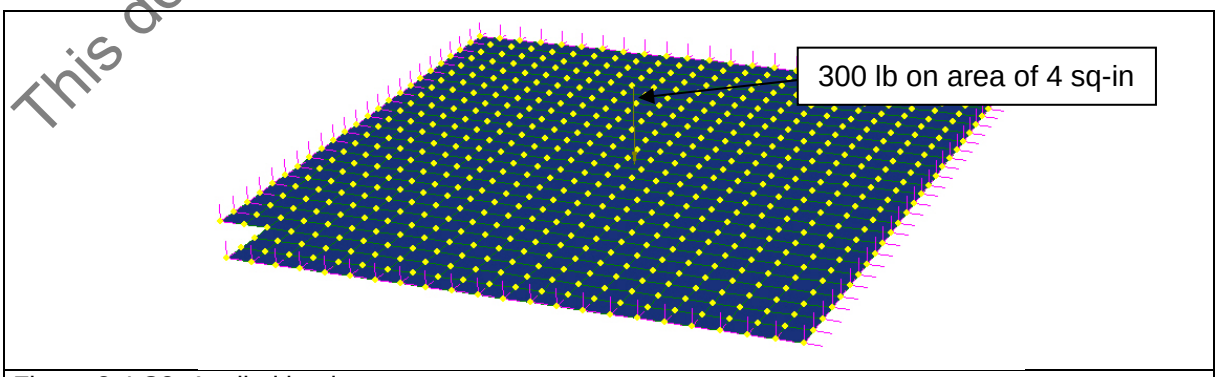

Figure 3: LC3: Applied load

4.3 Load case combination

Load case combination	Description	Note
Load capability		
LCC 1.1	LC 1 +1/2 LC 2	Dead load + uniformly distributed live load, 1 sheet
LCC 2.1	LC 1 +1/2 LC 3	Dead load + concentrated live load, 1 sheet
Serviceability		
LCC1.2	LC 1 + LC 2	Dead load + uniformly distributed live load, 3 sheets
LCC2.2	LC 1 + LC 3	Dead load + concentrated live load, 3 sheets

5 System model

The calculations were done with the finite element method. The software package is Strand 7. The model uses plate elements.

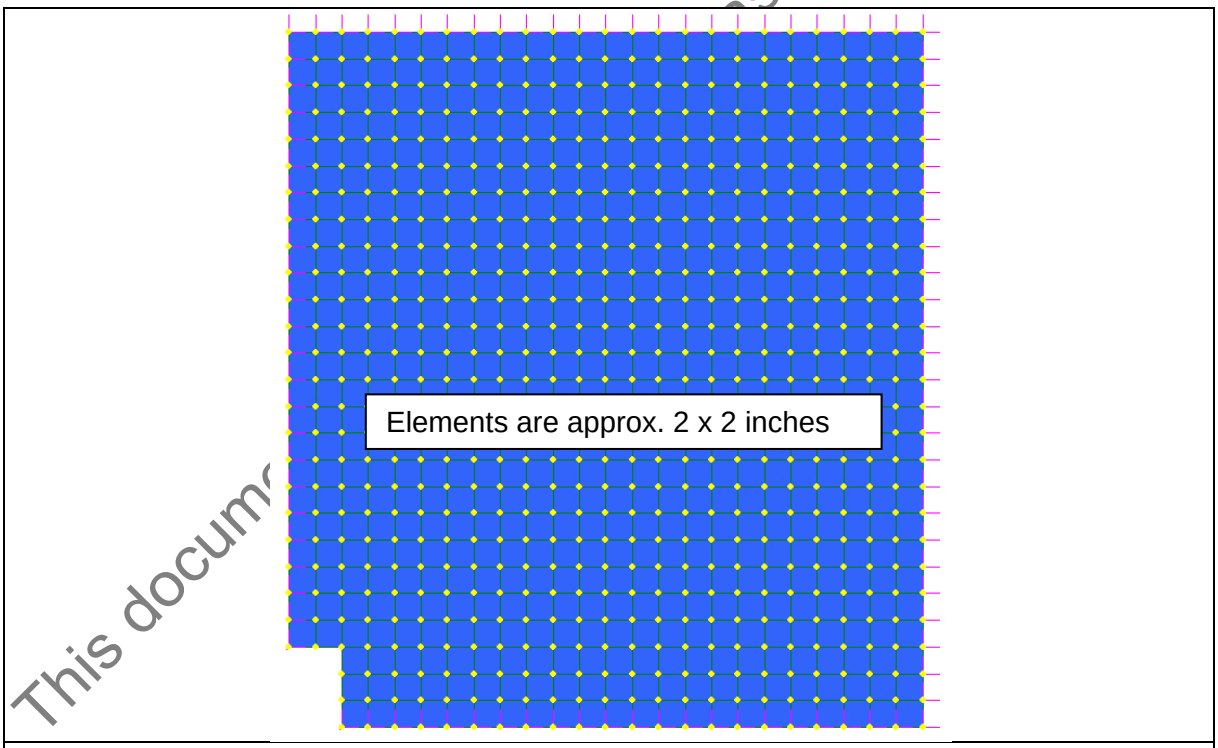

Figure 4: Mesh

6 Stresses and deflections

The calculation includes geometrical nonlinearity.

6.1 Deflections - serviceability state

In the following calculation three sheets are considered.

LCC 1.2: Dead load + uniformly distributed live load

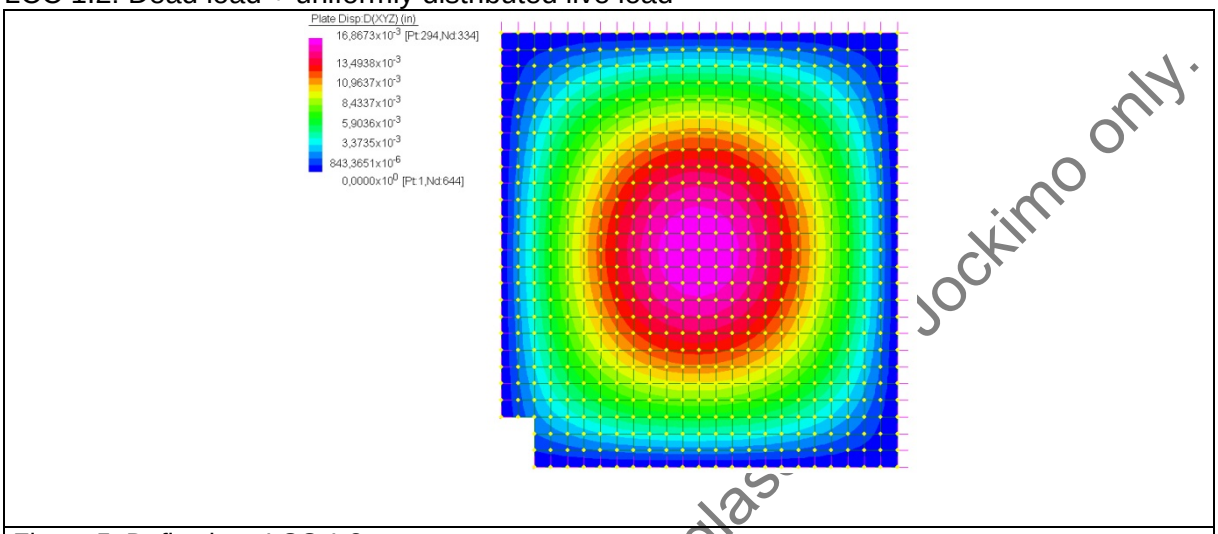

Figure 5: Deflections LCC 1.2

Max. deflection:	0.017	in

LCC 2.2: Dead load + concentrated live load

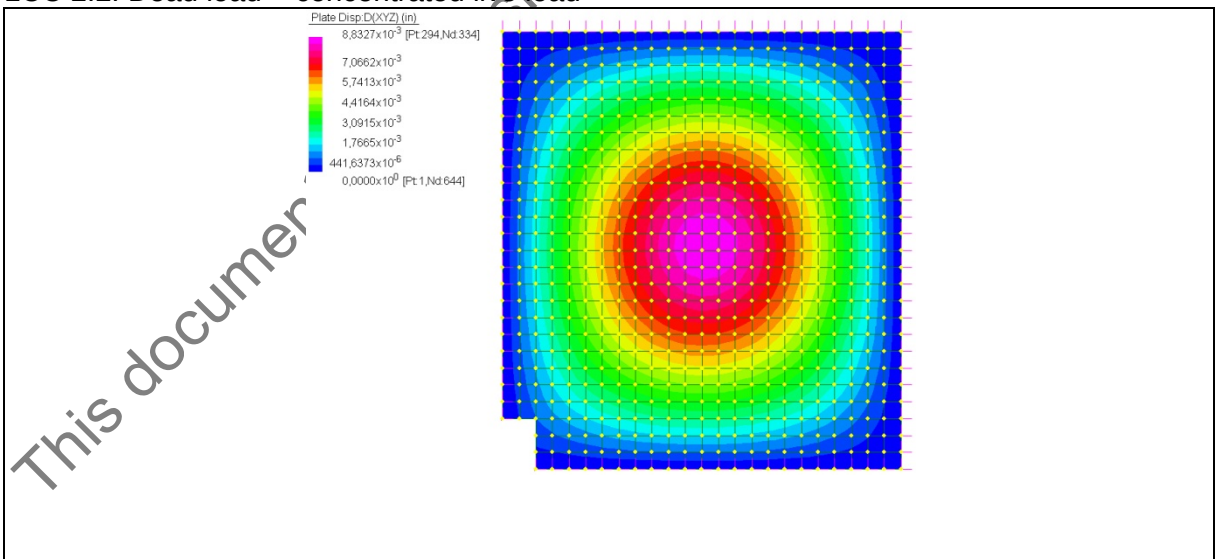

Figure 6: Deflections LCC 2.2

Max. deflection:	0.009	in

6.2 Stresses

In the following calculation only one sheet is considered with half of the load.

LCC 1.1: Dead load + uniformly distributed live load

Plate stress 11

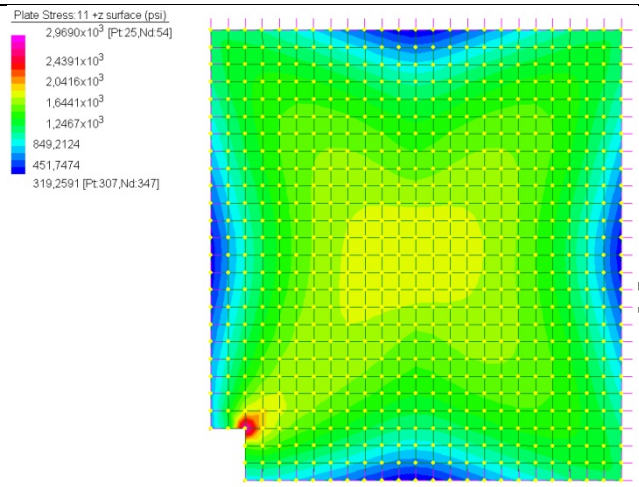

Figure 7: Stresses 11 LCC 1.1

Max. stress:	2,969	psi

Plate stress 22

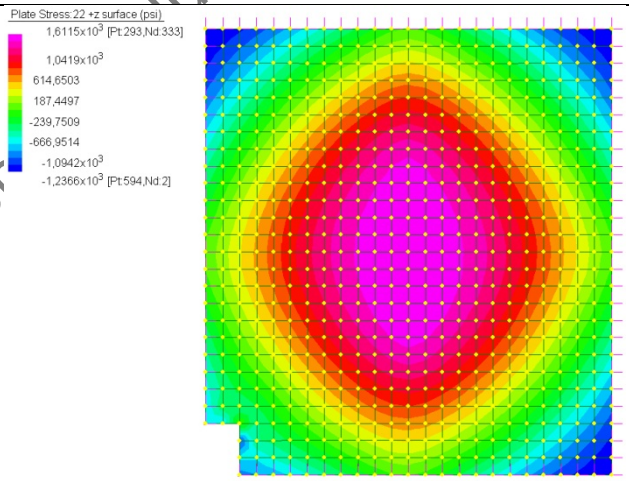

Figure 8: Stresses 22 LCC 1.1

Max. stress:	1,612	psi

C 2.1: Dead load + concentrated live load

Plate stress 11

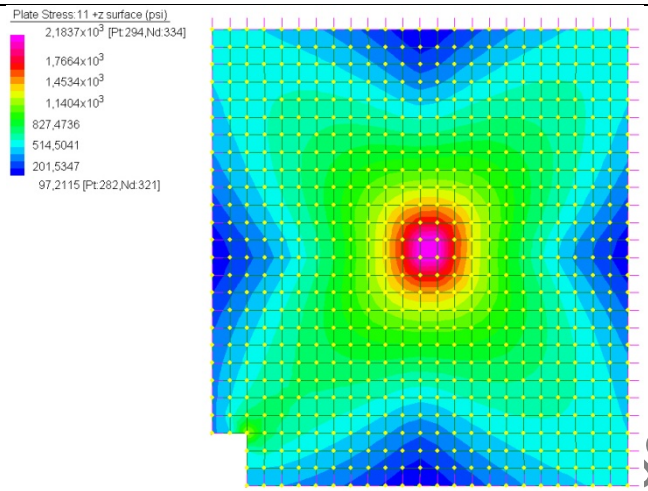

Figure 9: Stresses 11 LCC 2.1

Max. stress:	2,184	psi

Plate stress 22

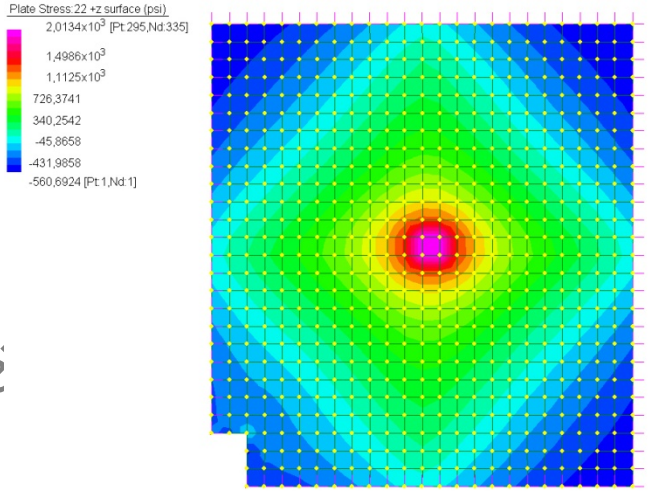

Figure 10: Stresses 22 LCC 2.1

Max. stress:	2,013	psi

6.3 Requirements and Performance by Code

It is assumed that the edges of the glass sheets are seamed or polished.

Code	Criteria	Value
IBC, Chapter 16, Table 1604.3	Deflection	L/360
ASTM E1300	Stresses Load duration 10 years	3,878 psi

6.4 Requirements by the manufacturer

In this case there are no additional requirements by the manufacturer.

6.5 Displacements

L= 48”

LCC 1.2: Dead load + uniformly distributed live load

Deflections	Value	Confirmation
0.017’’	L/360 = 48/360 = 0.133’’	o.k.

6.6 Stresses

LCC 2.1: Dead load + concentrated live load

Design stress	Value	Confirmation
2,969 psi	3,878 psi	o.k.

6.7 Summary

The analysis of the stresses and deflections show sufficient safety for the glass panels.

7 References

1. IBC International Building Code
2. ASCE Standard ASCE/SEI 7-05
3. ASTM C1048 “Standard Specification for Heat Treated Flat Glass”
4. ASTM C1172 “Standard Specification for Laminated Architectural Glass”
5. ASTM E 1300-2003 “Standard Practice for Determining Load Resistance of Glass in Buildings”
6. ASTM C1036 “Standard Specification for Flat Glass”
7. CPSC 16 CFR Part 1201 “Safety Standard for Architectural Glazing material”
8. GANA, Glass Association of North America “Glazing Manual”
9. Schuler, Christian, Omer Bucak, Vincent Sackmann, Holger Graf, Gert Albrecht. Time and temperature dependent mechanical behaviour and durability of laminated safety glass. Structural Engineering International, Feb 2004.

This report includes 12 pages.

Lutz Schöne, 09-07-14