Short note

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Subject: Environmental Impact Assessment for proposed Thermal Oxidiser at Tata Steel Colors, Shotton

1. Introduction

It is proposed to install a regenerative thermal oxidiser (RTO) at the Coatings 2 plant at Tata Steel's Shotton site. The new plant will make use of an existing (relocated) stack and this note discusses the potential environmental impact of the RTO emissions.

2. Stack characteristics and nearby buildings

The new location of the stack will be adjacent to 24 Bay in the Coatings 2 plant, as shown in Figure 1. The stack is 23 metres tall and 1.5 metres in diameter.

Buildings in the vicinity of a stack can have a significant effect on pollutant dispersion unless the stack is at least 2½ times as tall as the buildings; thus for a 23 metre stack, buildings lower than 9 metres would not be expected to affect dispersion, but taller ones may. LiDAR data for this area with a 1 metre horizontal resolution are available from the NRW archive[1] and were used to determine the heights of nearby buildings as shown in Figure 2. Several buildings taller than 9 metres were identified and for the purposes of dispersion modelling, these buildings were simplified into the four buildings shown in Figure 1. The heights of the composite buildings were set at the maximum of the height of the main bays included in each group, but the elevated sections shown arrowed in Figure 2 were disregarded as they comprise only a small proportion of the total building area.

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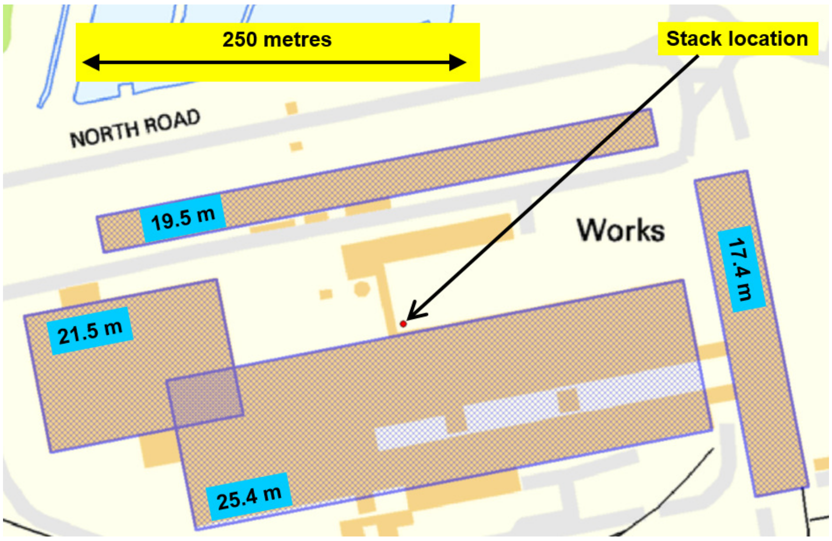

Figure 1: Location of stack and nearby buildings

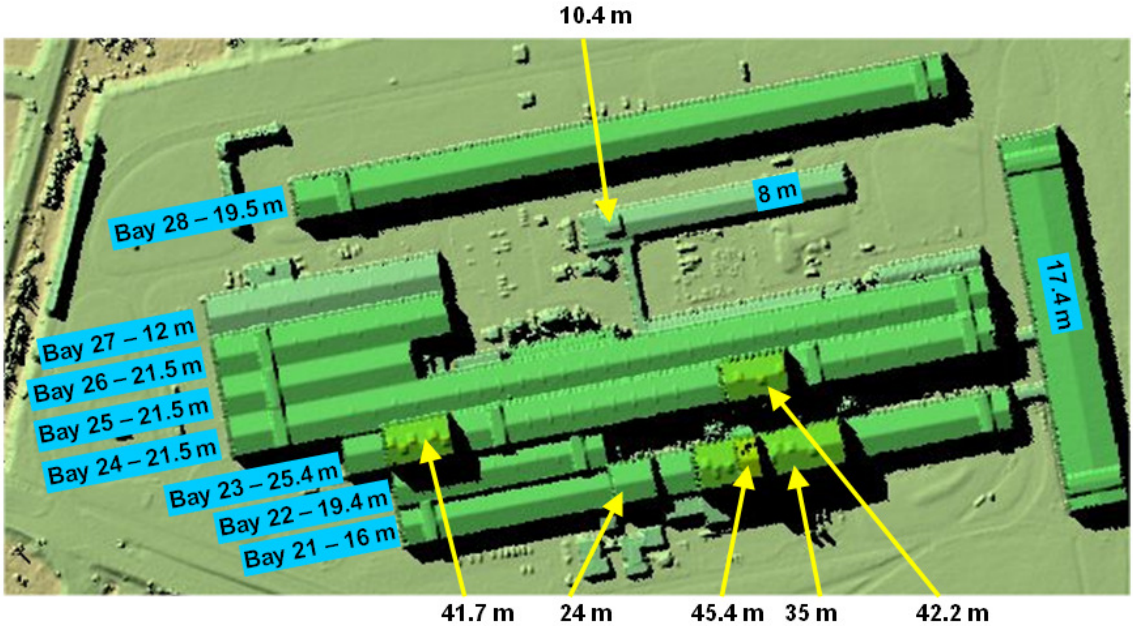

Figure 2: LiDAR image of Coatings 2 buildings and ridge heights

3. Waste gas characteristics and emissions

The waste gas flow and exit temperature will vary with process operations and for the purposes of this assessment a range of scenarios has been modelled. Information from the suppliers[2] indicates that the minimum flow will be around 25,000 Nm^3/hr (which accounts for the coater room extraction volume plus oven ingress and combustion air) and the maximum around 41,000 Nm^3/hr (based on a solvent load of 364 litres/hr, not including any water quench exhausts). The gas temperature after the secondary heat exchanger could range from about 180°C to 300°C depending on process conditions.

The waste gas will be largely air with some combustion products and the specific heat capacity and mean molecular weight are assumed to be 1,012 J/°C/kg and 28.996 kg/kmol respectively (ADMS default values).

The RTO is designed to achieve emissions of no more than:

- 20 mg/Nm^3 residual VOCs
- 100 mg/Nm^3 CO
- 100 mg/Nm^3 NO_x

Solvents from paints used on the Colorcoat Lines at Shotton are a complex mixture of VOCs, the composition of which will vary depending on the formulation of the particular paint; because of the large number of different formulations there is no standard description of the specific VOCs that may be emitted. Defra's guidance[3] on risk assessments for emissions to air states:

> If you release volatile organic compounds into the air and don't know what all the substances in them are, treat them all as 100% benzene in your risk assessment.

For the purposes of this assessment, a worst-case assumption has been made that emissions may be continuously at the Emission Limit Values throughout the year and the pollutant emission rates at different waste gas flowrates would therefore be:

- 25,000 Nm^3/h – 0.14 g/s benzene, 0.69 g/s CO, 0.69 g/s NO_x
- 41,000 Nm^3/h – 0.23 g/s benzene, 1.14 g/s CO, 1.14 g/s NO_x

4. Dispersion modelling

Dispersion modelling has been undertaken using ADMS version 5.1.2, released in February 2016.

4.1 Terrain

The ADMS dispersion model can take account of hills or other significant terrain features, but the accompanying user guide[4] (page 125) indicates that this is usually relevant only if slopes exceed 1:10, which is not the case in the vicinity of the Tata Steel site at Shotton. The complex terrain module has not been used for this assessment.

Surface roughness is dependent on land-use and in heterogeneous terrain no single value will correctly characterise the whole modelling domain. The area surrounding the Tata Steel site is largely flat with relatively few residential and industrial areas and a value of 0.3 metres was selected for this assessment.

4.2 Meteorological data

The Meteorological Office station closest to Shotton where all the data required for the ADMS model have been collected for at least five years is at Shawbury, 50 km SSE of the site. To minimise errors attributable to using such a distant meteorological station, wind speed and direction data from a local site at Hawarden airfield, 7 km SE of Shotton, has been used instead of the wind data from Shawbury. The final dataset input to the dispersion model comprises hourly sequential data covering wind speed and direction from Hawarden along with cloud cover, surface temperature, precipitation and relative humidity from Shawbury. The surface roughness at the meteorological station been assumed to be the same as for the Tata Steel site, i.e. 0.3 metres.

The meteorological data used for this assessment is for the years 1996 to 2000. The use of five years' data is expected to include enough variability to ensure that worst-case conditions are identified in the assessment. Although climate change is a major global concern, this relates to changes over many decades and data from 1996 to 2000 are still valid for the purposes of this assessment.

To account for the heat generated from the urban areas and industrial activities in the area, which limits the stability of the atmosphere (the "urban heat island" effect), the option within ADMS to specify a minimum value of the Monin-Obukhov length was used. The default value for "Mixed urban/industrial" of 30 metres was selected. The values of the surface albedo and the Priestly-Taylor parameter were left at the default values of 0.23 and 1.0 respectively.

The latitude of Shotton, which is used within the ADMS model to calculate surface heat flux, is approximately 53 °N.

4.3 Receptors

The impact of emissions from the proposed RTO stack over an area of 5 km x 3½ km has been assessed and Figure 3 shows the extent of this grid. In addition, a number of specific points were selected to assess the worst-case impact at different types of receptor where relevant population exposure may occur and these are also shown in Figure 3. The results from the overall output grid, as illustrated in Figures 4 and 5, confirm that the specific receptors are correctly located to capture the peak concentrations.

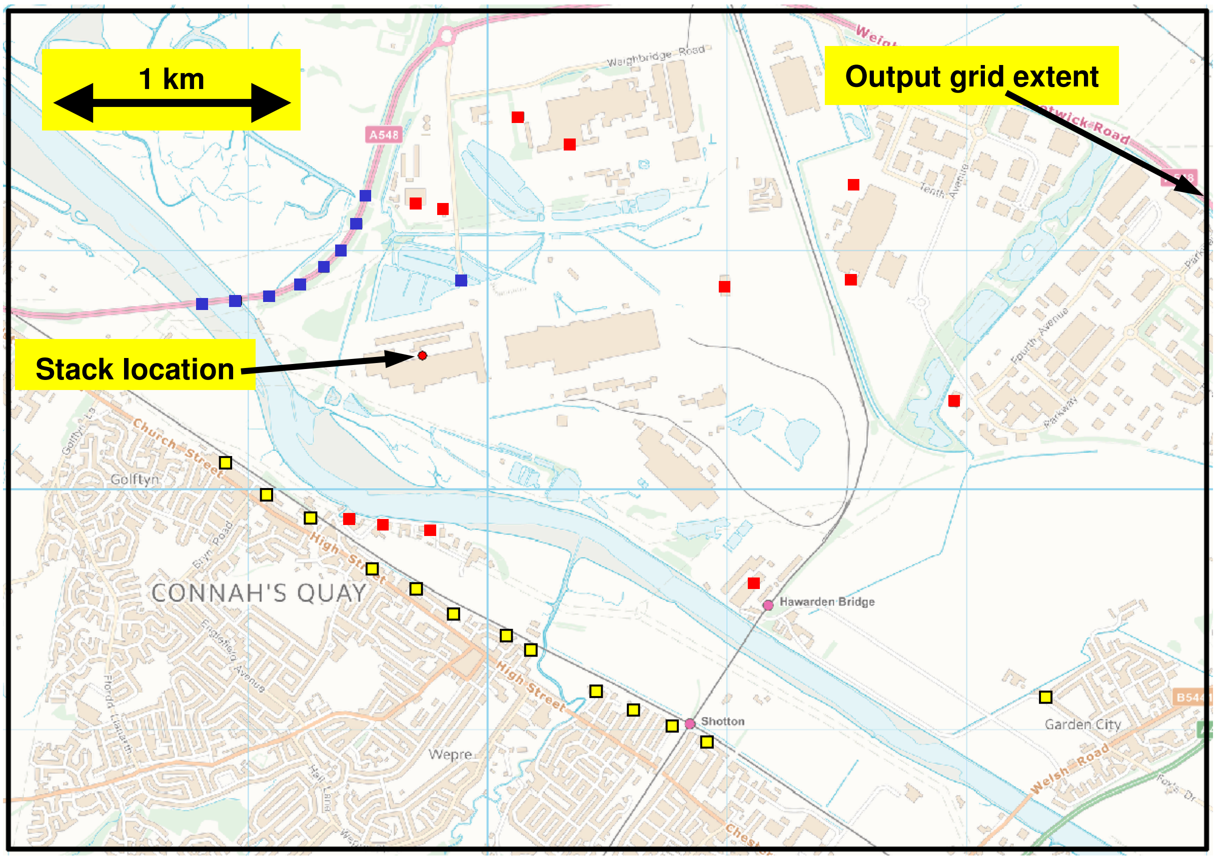

Figure 3: Extent of the output grid and specific receptors

The receptors illustrated in Figure 3 can be divided into three types:

- Residential areas (Yellow) – twelve receptors in Connah's Quay and one in Garden City
- Commercial premises (Red) – three receptors along the south bank of the Dee in Connah's Quay and nine in an arc from north to south-east of the Coatings 2 plant
- Other receptors (Blue) – eight receptors along the A548 to the north and north-west of the Coatings 2 plant and one at the Tata Steel gatehouse

4.4 Conversion of NO_x to NO_2

In the case of NO_x, most of the emission will be in the form of NO, whereas the most significant human health impacts are associated with NO_2. NO will naturally oxidise to NO_2 in the atmosphere, but this process will take place over timescales of hours to days, and over the short distances and timescales in this study the conversion will be far from complete. Although the ADMS dispersion model includes a module to account for NO_x chemistry, this requires detailed data on hourly average background levels of NO, NO_2 and ozone, which are not readily available for the area around Shotton. As an alternative to detailed treatment of NO_x chemistry, the guidance[3] on risk assessments for emissions to air provides the following recommendations for a conservative assessment:

- For assessment of short-term impacts, assume 50% conversion of total NO_x to NO_2
- For assessment of long-term impacts, assume 100% conversion of total NO_x to NO_2

These factors have been applied to the modelled total NO_x concentrations predicted by the dispersion model in this study.

5. Modelling results

Four emission scenarios were included in this modelling study (maximum and minimum waste gas flowrate coupled with maximum and minimum waste gas temperature). The dispersion model was run with five different years' meteorological data for each scenario and the results summarised in Table 1 are the maximum modelled values for any of the five years. The table shows the highest Process Contribution (PC) at each receptor type attributable to the potential emissions from a new thermal oxidiser at the Coatings 2 plant at Tata Steel's Shotton site. Also in the table are the relevant Air Quality Standards and Environmental Assessment Levels taken from Defra's risk assessment guidance[3].

				Highest modelled Process Contribution (µg/m³)			
		AQS or EAL	Flowrate:	41,000 Nm³/h		25,000 Nm³/h	
Species	Statistic	(µg/m³)	Temperature:	300°C	180°C	300°C	180°C
Benzene	Annual average	5	Residential receptors	0.023	0.028	0.020	0.020
	Maximum hourly average	195		1.2	1.4	0.8	1.1
CO	Maximum 8-hour running average	10,000		4.8	6.4	3.6	4.7
	Maximum hourly average	30,000		5.7	6.8	3.7	5.3
NO_2	Annual average	40		0.12	0.14	0.10	0.10
	99.8th percentile of hourly averages	200		1.8	1.9	1.1	1.5
Benzene	Annual average	5	Commercial receptors	0.10	0.13	0.08	0.09
	Maximum hourly average	195		1.5	1.8	1.1	1.8
CO	Maximum 8-hour running average	10,000		5.3	5.9	3.5	6.2
	Maximum hourly average	30,000		7.5	8.9	5.3	8.8
NO_2	Annual average	40		0.50	0.62	0.37	0.46
	99.8th percentile of hourly averages	200		2.8	2.7	1.7	2.3
Benzene	Annual average	5	Other receptors	0.17	0.21	0.12	0.15
	Maximum hourly average	195		2.6	3.2	1.9	2.3
CO	Maximum 8-hour running average	10,000		10	14	8	9
	Maximum hourly average	30,000		13	16	9	11
NO_2	Annual average	40		0.84	1.03	0.62	0.74
	99.8th percentile of hourly averages	200		6.0	7.2	4.4	5.3

Table 1: Modelled Process Contributions

In all cases, the potential impact is small compared to the environmental standards. Defra's guidance[3] on risk assessments for emissions to air states that an emission can be screened out as insignificant if the Process Contribution meets both of the following criteria:

- the long-term PC is less than 1% of the long-term environmental standard
- the short-term PC is less than 10% of the short-term environmental standard

For the residential receptors, the most significant long-term impact is for benzene. Taking a worst-case assumption that 100% of the residual VOCs emitted are benzene, the annual average may be up to 0.028 µg/m³ (0.6% of the Air Quality Standard) in Connah's Quay. The most significant short-term impact is for NO_2 – the 99.8th percentile of hourly averages in residential areas may be up to 1.9 µg/m³ (1% of the AQS). Thus for the residential receptors, the insignificance criteria are met.

In the case of the commercial and other receptors, annual average PCs are not relevant as there is no long-term population exposure. The most significant short-term impact is for NO_2 – the 99.8th percentile of hourly averages may be up to 7.2 µg/m³ (3.6% of the AQS) at the gatehouse. This is still less than the 10% criterion for screening out short-term impacts.

Figures 4 and 5 illustrate the pattern of dispersion in the vicinity of the Tata Steel site. Figure 4 shows the long-term benzene concentrations (assuming all VOCs are benzene) attributable to the potential emissions from the new thermal oxidiser at the Coatings 2 plant using the dataset giving the highest PC at any of the residential receptors.

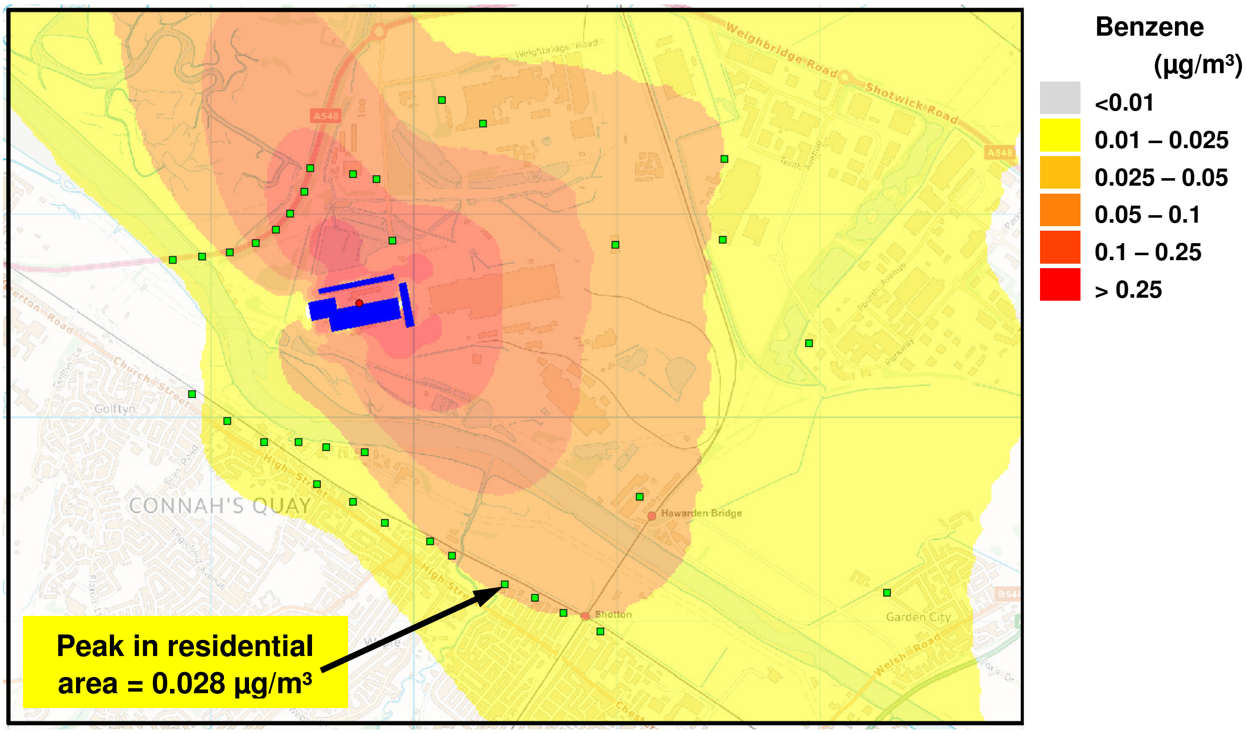

Figure 4: Annual average benzene concentration
41,000 Nm³/h waste gas flow, 180 °C waste gas temperature, 1998 meteorological data

Figure 5 shows the short-term NO_2 concentrations using the dataset giving the highest PC at the gatehouse.

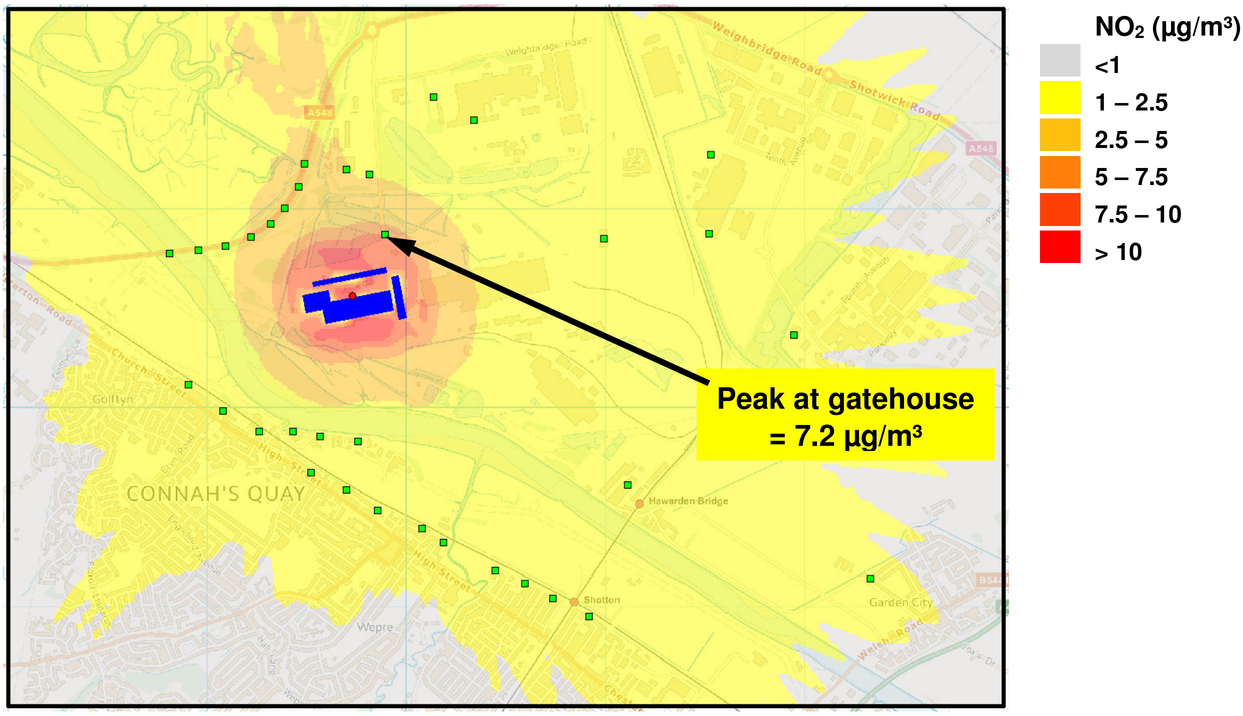

Figure 5: 99.8th percentile of hourly average NO_2 concentrations

41,000 Nm³/h waste gas flow, 180 °C waste gas temperature, 1997 meteorological data

It should be noted that the results quoted in Table 1 and illustrated in Figures 4 and 5 represent a conservative assessment, as a number of worst-case assumptions have been made in the analysis:

- Emissions are continuously at the Emission Limit Value throughout the year
- VOC emissions are 100% benzene
- 100% of NO_x emitted from the RTO is converted to NO_2 for the assessment of long-term impacts and 50% for short-term impacts
- Results are quoted for whichever year of meteorological data gave the highest figure

6. Conclusion

Dispersion modelling suggests that the reuse of the existing stack for the proposed thermal oxidiser will provide adequate dispersion for the likely pollutant emissions and there will be no significant environmental impact.

7. References

1. http://lle.gov.wales/GridProducts#data=LidarCompositeDataset
2. Email from Lois Scott, Spooner Industries Limited, dated 03/03/16
3. “Air emissions risk assessment for your environmental permit”, www.gov.uk/guidance/air-emissions-risk-assessment-for-your-environmental-permit
4. “ADMS 5 User Guide version 5.1”, Cambridge Environmental Research Consultants Ltd., May 2015