

Research aircraft flight for gas leakage investigation at the Elgin wellhead gas platform in the North Sea - initial results

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Abstract: -The Elgin wellhead platform is a gas platform located in the North Sea between Norway and Scotland, about 240 km east of Aberdeen. On 25 March 2012 an incident occurred at the platform, which resulted in an uncontrolled continuous emission of gases. The company Total, which owns and operates the platform, estimated a gas flux of approximately 200 000 m³/d a few days after the incident decreasing to an amount of approximately 50 000 m³/d several weeks after the incident. It was suspected by some environmental organizations and German media that other gases as e.g. the highly toxic gas H₂S were emitted as well in smaller concentrations by the leakage. In contrast to this Total stated that the gas had no appreciable H₂S content and that in early measurements as well as from other data sources no H₂S could be found in the emissions. Because of the danger of explosion the platform was evacuated shortly after the incident and a 3 miles exclusion zone around the gas platform was established for aircraft as well as a 2 miles exclusion zone for vessels. This paper gives results of an aircraft research flight which was performed by the Duesseldorf University of Applied Sciences on 12 May 2012 near the platform with special permission to operate within the exclusion zone. The main aim of this research flight was the independent investigation of methane and potential H₂S concentrations near the platform some weeks after the starting of the leakage. It could be confirmed by this flight, that the methane concentrations downwind to the Elgin platform had only moderate levels some weeks after the starting of the leakage. Moreover, no concentrations of the poisonous gas H₂S could be detected during the flight even with very sensitive on-line instrumentation.

Key-Words: Elgin gas platform, research aircraft, FTIR measurements, methane, H₂S, gas plume, IR camera

1 Introduction

The Elgin gas field was discovered in 1991. In 1997 first wells were drilled and in 2001 the gas production began. On 25 March 2012 an incident occurred during well intervention operations on the Elgin wellhead platform resulting in a severe gas leakage. No personnel were injured, but the platform had to be evacuated [1]. In these days there was a significant danger of explosion of the platform. Therefore it was prohibited for aircraft to enter an exclusion zone of 3 miles around the gas platform [2]. For vessels an exclusion zone of 2 miles was valid.

However, in the meantime several reconnaissance actions were started in parallel by the company Total to get information about the amount of gas release and composition of the gas [1] and several research flights were performed in order to get visual information and measurement results of the leakage [3]. Moreover, different counter measures were started by Total to reduce and finally stop the gas leakage [1]. First estimates of Total of the gas release were about 200 000 m³/d corresponding to approximately 2 kg/s. As Total concluded from several investigations, this gas release decreased in the following weeks to a value of 50 000 m³/d, corresponding to approximately 0.5 kg/s [4].

However, in Germany it was suspected by environmental organizations and in press publications that the gas emissions of methane were accomplished by emissions of the poisonous gas H_2S as well (see e.g. [5,6]). In this situation Greenpeace started a measurement campaign with a small vessel, taking air and water samples right at the border of the exclusion zone at the beginning of April 2012. After analysis of the Greenpeace samples it turned out, that the methane concentrations at the border of the exclusion zone were around background concentrations [7]. However, these results were gained at sea level at the border of the 2 miles exclusion zone.

At that point still the question arose, what concentrations were present within the exclusion zone next to the Elgin platform and at elevated altitudes, as it could be possible that the methane plume was transported at higher altitudes and not at sea level, because methane is lighter than air.

In this situation the Duesseldorf University of Applied Sciences performed a research flight on 12 May 2012 to the Elgin platform for several reasons:

- The flight should deliver measurement results by an independent organization concerning methane and H_2S concentrations near the Elgin platform some weeks after the start of the leakage, additionally to the investigations which had been performed before [1,3,7].
- The flight should deliver if even possible measurement results within the exclusion zone next to the Elgin platform.
- High sensitivity on-line instrumentation for H_2S should enable the detection of even very small amounts of H_2S in the ppb-range, if present.
- A flight path circulating around the Elgin platform from low altitudes (about 75 m) increasing to high altitudes (about 1000 m) should ensure to catch the plume emitted from the platform.

2 Measurement systems

A Partenavia P68 twin engine aircraft was used for this study. It was able for VFR and IFR flights.

For the measurements of methane, propane, butane CO_2 , N_2O and some other compounds a mobile

FTIR measurement system, equipped with a multireflexion gas cell was used (Ansyco Environnement GASMET). This system has the advantage of a high sensitivity for methane and the capability for monitoring methane concentrations around background levels with a repetition rate of 6 seconds.

For the measurement of the poisonous H_2S a gas sensor Arizona Jerome J605 was used. This gas sensor had the advantage of a very high sensitivity for H_2S in the low ppb range and is one of the most sensitive portable measurement systems on the market (detection limit 3 ppb). The measurement principle is based on the electrical resistivity change of a gold film by an H_2S gas load.

Additionally to the gas measurement systems an IR camera (Xenix Onca MWIR-InSb) with subsequent spectral analysis was used, for visualizing the potential methane plume.

3 Research flight

The research flight was performed on 12 May 2012. A special permission was received for entering the exclusion zone with the research aircraft. The area of the Elgin platform was reached at about 4 pm local time. The measurements were performed by circulating spiral flights starting from about 75 m above sea level up to about 1000 m above sea level. More than 30 spiral circles were flown around the platform to make sure to catch a potential plume of methane or other gases.

In figure 1 the Elgin platform is shown as it could be seen from the aircraft. On the right hand side the wellhead platform with the gas leak can be seen (with Rowan Viking jack up drilling rig). In the middle the gas separation station is shown.



Figure 1: Photo of the Elgin platform from the aircraft.

On the left hand side a special vessel (West Phoenix) is located with a dynamic positioning system and equipment for the leaking well intervention with heavy mud. The well intervention started 15 May 2012, a few days after the research flight of the Duesseldorf University of Applied Sciences. Therefore this research flight gives valuable gas concentration information of the atmosphere around the Elgin platform right before the start of the well intervention.

Figure 2 shows the flight track of the aircraft around the Elgin platform. As it can be seen clearly the aircraft was climbing up in multiple circulating spiral flights from 75 m to about 1000 m altitude.

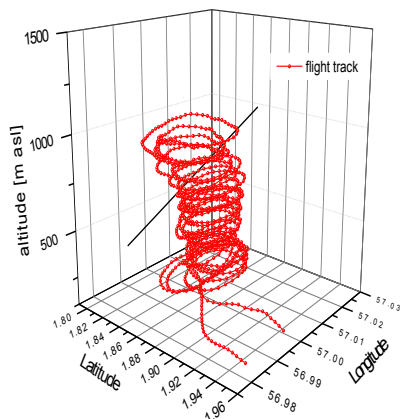


Figure 2: Flight track of the aircraft spiraling up around the gas platform in the middle.

4 Results of research flight

4.1 Results during the flight approaching the platform.

During the flight approaching the Elgin platform the compounds methane, butane, CO_2 , N_2O were monitored continuously by the FTIR system. Moreover H_2S concentrations were monitored with a repetition rate of several seconds.

Methane concentrations were measured to be around standard background levels of about 1.7 ppm during the approach to the Elgin platform. H_2S concentrations were found to be below the detection limit of the Jerome instrument. This means, the H_2S concentrations were below 3ppb at the flight to the platform.

4.2 Results during the spiral flights around the Elgin platform

The results of methane and butane measurements together with the flight altitude during the spiral flights around the platform are shown in Figure 3.

As it can be seen in Figure 3 the spiral flight altitude at the platform was constantly increased from 75 m above sea level to about 1000 m above sea level. During most time of the spiral flights the measured methane concentrations were about background concentrations at upwind sites of the Elgin platform. At downwind sites of the Elgin platform the concentrations increased up to about 1.9 – 2.0 ppm. That means, during the spiral flights no significantly elevated concentrations were found.

However, after terminating the spiral flights of the research aircraft an additional flight track at low levels away from the platform was chosen. At this flight track at low altitude above the sea elevated concentrations of methane up to about 2.9 ppm could be found in downwind direction from the platform. That means that evidently a distinct methane plume was transported by the wind at low altitude in downwind direction. The track of this plume could be recorded at an altitude of 75 m for several kilometers downwind of the platform. However, although the plume could be clearly monitored by the research aircraft, the concentration level can be regarded as moderate.

The result that only moderate downwind concentrations could be detected by the FTIR system during the research aircraft flight is supported by the fact that the IR-camera images, which were taken during the flight, did not reveal an IR visible methane plume during the flight. In contrast to this some weeks before Greenpeace had published an IR-picture of a plume at the Elgin platform, which was interpreted as a methane plume originating from the gas leak [7]. However, during this research flight of the Duesseldorf University of Applied Sciences on 12 May 2012 the IR-Camera could not detect any IR-visible concentrated methane plume, although it was the same type of camera as used for the Greenpeace study before.

A distinct plume of butane could be monitored at an altitude between 400 m and 800 m. If this plume was originating from the Elgin platform or from another source cannot be confirmed at this point.

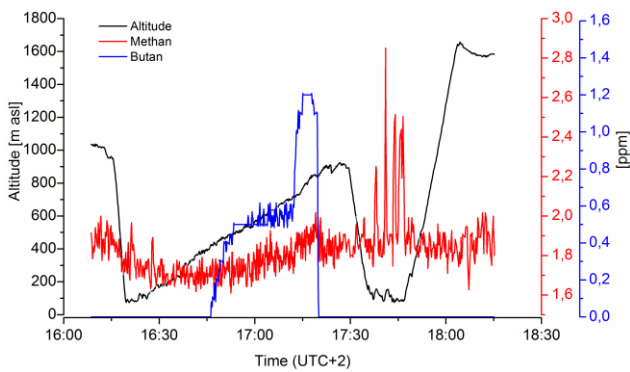


Figure 3. Methane and butane concentrations near the Elgin platform and flight altitude of the research aircraft.

It is of high importance, that during the whole flight near the platform no H_2S concentrations could be detected by the Jerome measurement system. That means, H_2S concentrations were below the detection limit of 3 ppb. Therefore it can be concluded that H_2S concentrations appeared not to be an environmental problem during the time of the flight.

Figure 4 shows the modeled and spline interpolated concentration profiles for methane modeled with the Surfer program. The figure clearly demonstrates methane concentrations around background near the Elgin platform with some moderately enhanced concentrations downwind to the Elgin platform.

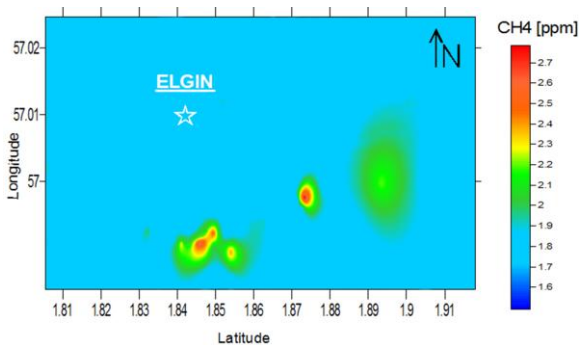


Figure 4: Spline modeled concentration profiles of methane concentrations near the Elgin platform

5 Conclusion

The independent research flight of the Duesseldorf University of Applied Sciences could demonstrate clearly that the methane concentrations downwind to the Elgin platform had only moderate levels. This confirms that evidently the methane emissions of the gas leak of the Elgin platform had already decreased at the time of the research flight. Moreover it is important to note, that no H_2S concentration could be detected during the flight. That means that either no H_2S concentration was present or below the detection limit of 3 ppb. This is an important result in view of the controversial discussion before concerning the occurrence of H_2S .

Author's contributions:

All authors joined the research flight and/or contributed to the evaluation of the data.

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