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A lot of hot air: Report on fire extinguisher misfire on s/v Jessica Mei

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Vessel: Jessica Mei, Island Packet 44, MMSI 235059182

Date of incident: Approx 1445 hrs UTC Tuesday 29th November 2022

Location: River Elbe, Germany, just before Kiel Canal entrance: 53°52'3 N 09°05'3 E, between Stbd buoys 55 & 57

Persons onboard: Bill Proctor (owner and skipper), Tim Newson (1st Mate and Instructor, YMI), Peter Sharpe (Crew), Jack Wheeler (Crew)

Context

We departed from Jessica Mei's home port of Chichester Marina on Saturday, 26th November 2022. Our destination was Hamburg City Sporthafen marina, 500NM away. We left on the high tide at Chichester with the wind increasing. During the first 12 hours, we had strong southerly winds gusting over F8 with wave heights of up to 4 metres. These conditions lasted until we got shelter from Cape Gris-Nez, after which the winds remained strong, but the sea state was much more comfortable. We continued non-stop to the mouth of the Elbe River.

Generally, everything was functioning well onboard Jessica Mei throughout the voyage. The rough conditions had, predictably, churned up some debris in the fuel tank, so the engine's revs were slightly fluctuating. This fuel starvation was remedied by changing over the course fuel filters, quickly done as Jessica Mei has a dual filter fitted. The heater was regularly on. However, we had noted that it should have been throwing out more hot air than it was, and we planned to get it serviced in Hamburg. Oil pressure and engine temperature gauges were working and were easily monitored from within the cockpit. The output from the alternator was also within acceptable parameters.

Our original plan was to sail to Hamburg over 3-4 days. Spend three days there, then catch the Easterly winds that were forecast. With this forecast, we planned to be back in Chichester by around Thursday, 8th December.

Fire extinguisher misfire

On the afternoon of Tuesday 29th, we were motoring up the Elbe, looking forward to getting into Hamburg early that evening. We had had a fast outward journey with plenty of wind. The wind was shifting to the East as we approached the Elbe, ready for our return home – as forecast.

I was downstairs in the galley when I heard the characteristic sound of a fire extinguisher go off. As I suspected no fire, I carefully opened the side engine hatch and was presented with a cloud of CO2 powder from an automatic fire extinguisher in the engine bay. I also heard the engine note change as it was starved of oxygen. I immediately told Jack and Bill, who were at the helm, to switch off the engine.

From hearing the fire extinguisher going off to the engine being turned off was approximately five to ten seconds maximum.

We were now adrift in a busy shipping lane. We contacted the local VTS and sailed onto to an anchorage in shallower water, out of the way of shipping, so that we could investigate what had happened.

Clean up & sail up the Elbe

Once safely anchored, we made a cup of tea and tried to figure out what had set the fire extinguisher off. Jessica Mei is fitted with two automatic engine extinguishers in the engine bay. Only the one on the port side of the engine bay had misfired (Fig. 1). Before the engine was shut down, Jack and Bill had seen the engine's operating temperature, which had all been normal, with no alarms sounding.

We decided that the best thing to do was to clean up the engine bay as best we could and attempt to restart. We opened all the hatches and used a dinghy foot pump to blow the CO2 powder from the engine. We also dismantled the engine air filter and took this outside to clear any CO2 powder thoroughly. Jack mainly carried out this work with me pumping the foot pump. We made cloth face masks, but it was hard to avoid inhaling some CO2 powder during this clean-up.

Fig. 1: Only the fire extinguisher on the right of the picture had fired. This photograph was taken after the initial cleaning with the dinghy pump.

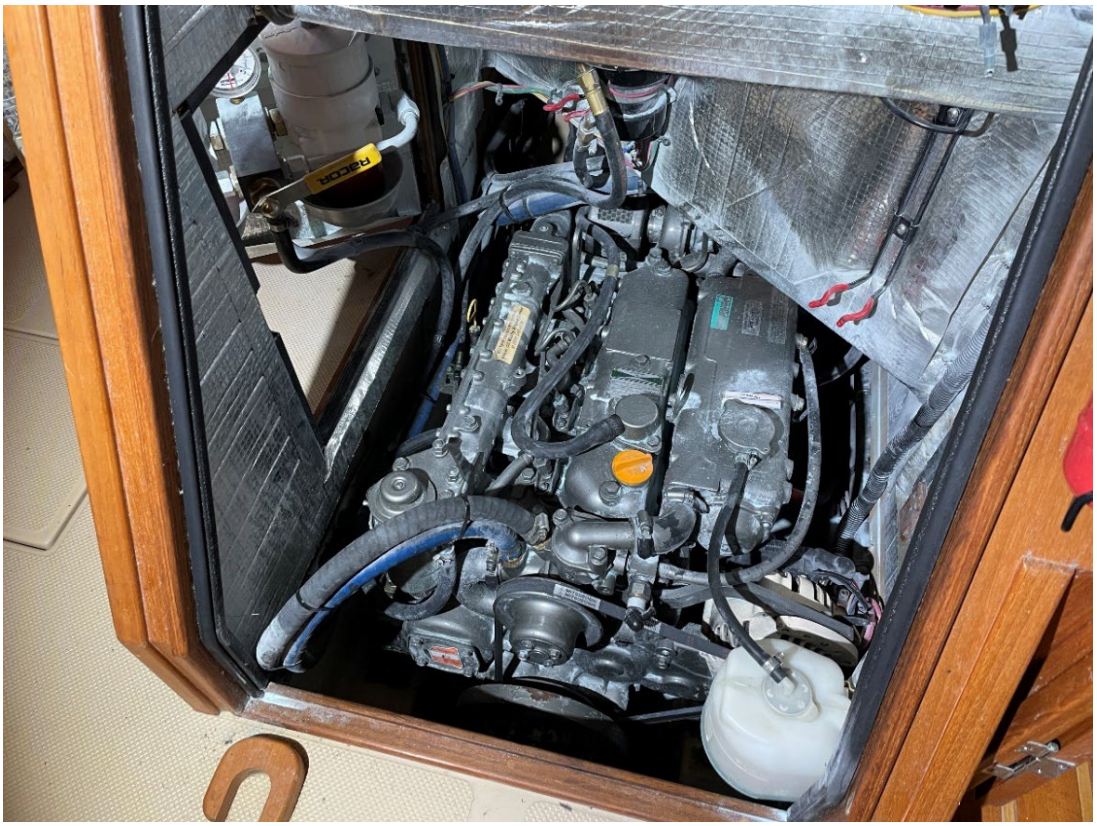

Fig. 2: The Yanmar 75hp engine after the initial clean with the dinghy pump.

With the engine as clean as possible without a vacuum (Fig. 2), we reinstalled the air filter and attempted restarting it. It took longer than usual to fire up; once going, there was loud metallic knocking from the engine that wasn't normal, so we immediately switched it off. We attempted to clean more, then tried starting the engine again. This time the engine started immediately, but the metallic ringing was still clearly heard, so we turned it off. We were concerned that permanent damage may have been done to the engine by the fire extinguisher powder and considered it should not be restarted until it had been checked over by an engineer.

We decided to stay at anchor that night. We suspected the boat might need to be hauled out for necessary works to be carried out to the engine or even that it would need to be replaced altogether due to bent pushrods, damage to the turbo or the cylinders and pistons themselves. As there were no marinas close by, and a tow from the anchorage to anywhere with facilities would have been very costly, we decided that our best option was to get up early with the last of the flood tide and continue up the Elbe under sail.

At this point, we were also concerned about the batteries. Although the batteries had been replaced just before our departure, the windlass clutch was seized, so we dropped the anchor using the windlass motor. Using the windlass without the engine running had run batteries down from fully charged to to reading only 12.3 volts, typically when we would start charging lead acid AGM batteries. It was, therefore, essential that wherever we went had a 240v hook-up to maintain the health of the batteries as we had no other way of charging. It was also quite cold onboard without the heating.

We got up at 3 am and, after notifying the VTS that we were setting off, pulled the anchor up by hand. This was very difficult so we tied a rolling hitch onto the chain and led the line onto a winch on the mast. We didn't use the electric windlass as the battery voltage was too low. Weighing would have been much easier if the clutch on the windlass hadn't been seized, as we could have used the manual override on the windlass.

Once the anchor was up, we unfurled the headsail and started tacking up the Elbe (Fig.3). As soon as we had a longer tack we also pulled out the main (Jessica Mei has in mast furling). We cleared the bend in the river just before the tide turned as planned. From there, we could hold one tack a lot easier with the easterly wind. As the winds were light – F2-3 – it took us 10 hours to cover the 35 miles or so to the outskirts of Hamburg. We considered going into marinas as we passed them. The first was Glückstadt, but they had no boat available to tow us onto a pontoon or a 240v hook-up. The Hamburger Marina was closed for the winter. Our original destination, Hamburg City Sporthafen, was our only option. While sailing up the Elbe, the batteries read 12.1v. To try and avoid permanent damage to the domestic batteries, Jack wired the engine start battery as the domestic supply, giving us plenty of power to run instruments.

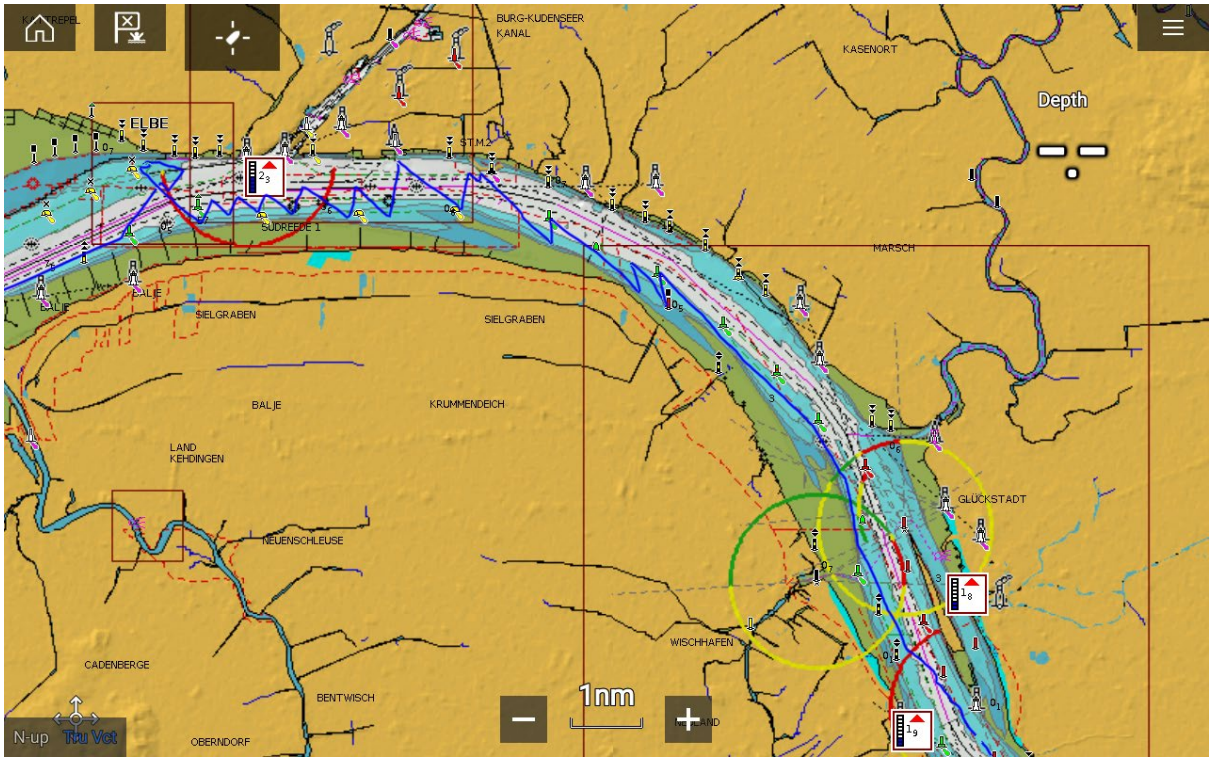

Fig. 3: Tacking up the Elbe, starting from our anchorage to the west of the entrance of the Kiel Canal

Fig. 4: Jack in the tender with the 6hp motor, Peter at the helm.

As we approached the city, the topography changed, blocking the wind on the river. We launched the tender with the 6hp petrol motor. Jack used it to push Jessica Mei at 2-3 knots STW (Fig. 4). All wind had gone now, and we entirely relied on the little 6hp motor to keep us moving. We covered another 5 NM or so in this way with the tide helping us. However, as each ship passed, the wash would make it impossible to keep pushing. Also, as we got closer to Hamburg, the Elbe has sections of tidal overfalls. It was clear that we would have little control as we went over these tidal overfalls, so we decided it was time to ask for the tow.

The tow was on its way to us, but we were increasingly losing control of Jessica Mei, close to the busy shipping lane. I, therefore, called Hamburg VTS to make them aware that urgent assistance was required for us to avoid being a hazard to shipping. It was not a mayday call because we were adrift and under no immediate danger. However, it could have quickly escalated into a mayday call if a ship had approached our position.

Hamburg VTS quickly sent a launch that took us alongside a commercial pontoon beside Gorch-Foch Park. This tow was free of charge. The Hamburg police then came to see us and took details of the incident. Soon after they had departed, the tow boat we had requested an hour or so before arrived. They then took us to central Hamburg (Fig. 5). We were tied up in the Hamburg City Sporthafen by around 1930 hrs UTC and able to plug in and charge the batteries, and get the heater back on.

Fig. 5: The final tow into central Hamburg

Diagnosis

We had already arranged for an engineer to come and check the engine the morning after. He attended and turned the engine over by hand then checked the air filter and tried to start it. The engine started as usual. It sounded ok, and then for about 5 seconds, the loud metallic knocking sound occurred again. This sound was likely caused by diesel knock – unexploded diesel in the cylinder due to the powder. The knocking then cleared, and the engine sounded normal. We left the engine running for 20 minutes or so.

With the engine now running normally, the engineer conducted various other checks. He found that the alternator was running very hot. The temperature sensor on the alternator had become detached, and the copper wiring inside the alternator was visibly blackened. (Fig. 6). I attempted to touch the alternator, but it was too hot.

Fig. 6: The wiring inside the alternator should be a bright copper colour. The copper fitting at the top of the picture is where the temperature sensor is attached.

He contacted an electrician to inspect the alternator, and they arranged to visit the following morning. The engineer confirmed that the engine appeared mechanically fine but asked us to run it for an hour or so under load before departing as a final test once the alternator issue had been resolved. He also requested that we use a vacuum to give the engine bay another thorough clean to stop any stray powder from entering the engine again.

The electrician found that the Balmar alternator had severely overheated and reported that the only thing to do would be to install a new Balmar alternator and regulator. These were not readily available in Hamburg. Later that day, he called to confirm that he would have a replacement by Tuesday, 6th December and would be able to come and fit it on the morning of Wednesday, 7th December. As this was our only option, we agreed to this timeframe, although we would miss our weather window of easterlies for easy sailing back to the UK.

The next day – Friday 2nd December – we borrowed a hoover, and Bill and Peter spent a few hours clearing up as much powder from the engine bay as possible.

During this clean-up, they accessed a locker behind the engine bay, under the quarter berth—this locker communicated directly with the engine bay via holes for pipework for the exhaust and other plumbing. Here we discovered that the heating duct had disconnected from a Y-connection in this locker (Fig. 7 and Fig. 8). The disconnection resulted in a lot of hot air from the heater being pumped directly into the locker, escaping through the holes made for pipework into the engine bay. The holes that communicated with the engine bay were on the port side of the engine bay. Positioned directly behind the alternator and below the extinguisher that misfired.

The heater was on when we discovered this. The locker walls were very hot to touch, as well as the engine bay, even though the engine has not been running that day.

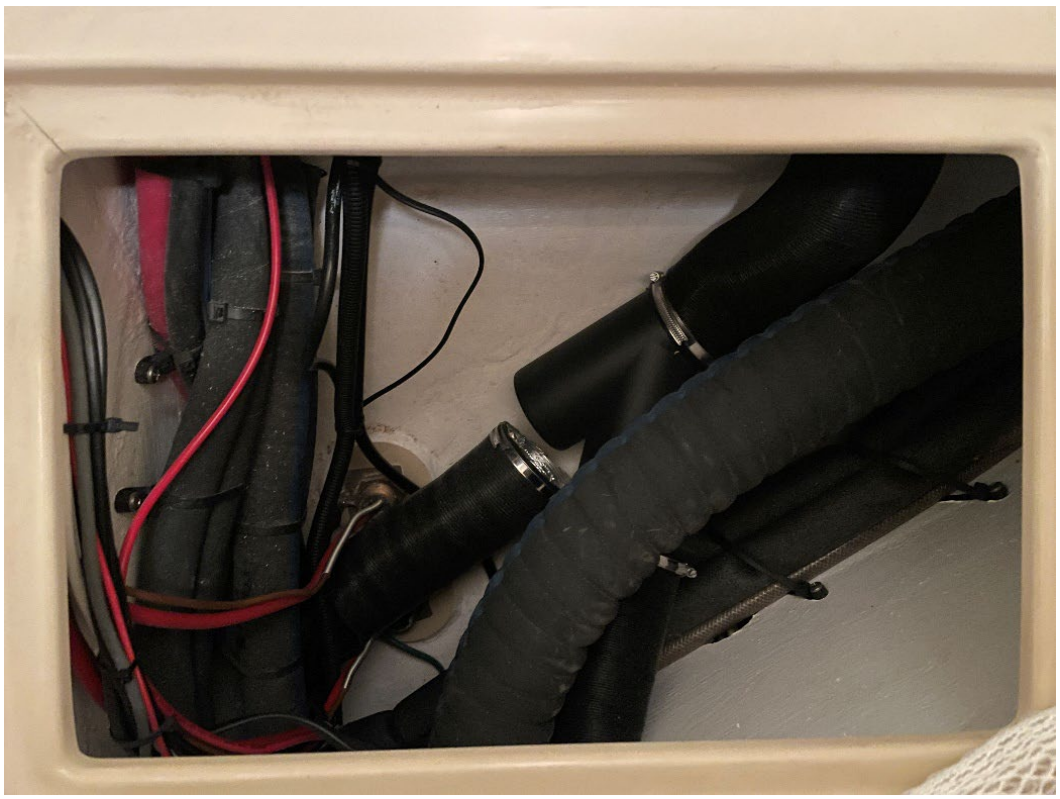

Fig. 7: The inboard quarter berth locker with the Y-connector in the heating duct. The walls of this locker were too hot to touch. The hole to the engine for pipework was to the bottom left of the picture.

Fig. 8: Close-up of Y-connector. Both connectors had become detached as pictured. The hot air was being blown directly into the port side of the engine bay.

Fig. 9: The heater in the cockpit locker. Notice how securely fitted the bilge pump pipes are compared to the retro fitted heater duct. As well as being well secured to the bulkhead this section of ducting should have been of a stronger material, or had a guard made around it, to prevent if from being damaged by items stored in the locker. The tape at the bottom is our repair to a 3” tear in the duct.

Following this discovery, the ducting for the heater was reconnected and the entire run was inspected. The ducting was repaired in the starboard cockpit locker, where the heater is. This run was very short and had no support or protection. It was inevitably knocked about by fenders kept in that locker while sailing. (Fig. 9)

With these ductwork repairs completed, we tested whether running the heater contributed to the engine bay temperature. The heater no longer affected the engine bay temperature, and we were much warmer than before.

In my spare time in Hamburg, I serviced the windlass so the anchor could quickly be dropped using the clutch.

The electrician came as scheduled and replaced the alternator and regulator. Once this was fitted, I changed all the fuel filters. We filled up with water and left that afternoon.

Unfortunately, the easterly winds that had been blowing while we were in Hamburg had passed, and we now had a mix of headwinds and cyclonic conditions. These winds meant we had to motor much of the way back to Chichester. This voyage took almost six days. We arrived in Chichester on the evening of Monday 12th December. Apart from lots of snow and an exploding mainsheet block during a squall, the return trip was uneventful, but we had to stop twice to refuel. The one benefit of this was we could be sure that the engine was working well and completely unaffected by the fire extinguisher.

Conclusion

We were initially baffled by the fire extinguisher misfiring. Once we discovered the disconnected heater ducting in the locker, it was clear that this was the cause. The engine bay is well insulated. The locker where the disconnection had occurred had a mattress above it. Both areas had efficiently trapped the heat from the heater until 80°C was reached and the fire extinguisher fired. Therefore, the fire extinguisher did not technically misfire – although there was no fire.

The heating system had been installed relatively recently, about 18 months ago. The run from the heater through the cockpit locker to the locker under the quarter berth was very short and stretched tight. It was inevitable that this would either pull off the Y connector or break entirely. It was also inadequately installed, with no supports or protection from other items stored inside the cockpit locker – such as the fenders. The ducting in the cockpit locker was pulled around by the normal motion of sailing and caused the Y connector under the quarter berth to become disconnected from the other ducts. The disconnection probably occurred soon after the heater had been installed. There was a 3” tear in this first length of ducting in the cockpit locker, which is further evidence that this length had not been installed with sufficient protection for going to sea.

The disconnection in the heater duct wasn't a problem until we had been motoring for a few hours with the heater working. As we had sailed most of the way until the Elbe, this was the first time we had used the motor for a prolonged time. Before, Jessica Mei was primarily used during warmer weather, so the heater had not been operating while the engine was on.

The hole where the hot air entered the engine bay was directly behind the alternator. As well as setting off the fire extinguisher, I am confident that the escaping hot air also overheated and damaged the alternator.

I can't be sure whether the temperature sensor broke due to this heat and extinguisher going off above it, or if it had broken beforehand. As many alternators do not have a temperature sensor, I do not think an overheating alternator could have set off the fire extinguisher on its own. It could have contributed to the heat in the engine bay though.

On inspection of the heating ducting throughout Jessica Mei, there were numerous locations where the ducting had been installed with little thought. In multiple locations, it compromised the locker space in a manner unsuitable for a seagoing vessel (Fig. 10). For example: the duct was left on the floor in the locker under the starboard settee (Fig. 11). This position meant it would be immediately squashed by anything put into that locker. There were also sections of the ducting that had lagging, mainly in the middle of the run. Then other sections had no lagging. There seemed to be no logic to the distribution of this lagging.

Fig. 10: The heater duct in the outboard quarter berth locker is badly exposed to being bashed around by whatever is stored there, emergency water in this instance.

Fig. 11: The ducting installation in the locker below the starboard settee has been left lying on the floor. This position means it's impossible to use this space for storage now. It would have been much better to mount the ducting higher up on the outside locker walls, keeping the bottom clear, so this sizeable locker space could still be used without the duct getting damaged.

Lessons

A small oversight can often lead to a chain of events that results in severe problems at sea. The heater installation on Jessica Mei is a typical example of this. While it's good to be mindful to avoid over-engineering, having well-thought-out ducting for heating that is securely fastened and well-protected from other items that are loosely stored in the spaces it shares should always be features of any heating installation. We were very fortunate that this incident occurred so close to shelter and that the fire extinguisher didn't permanently damage the engine requiring complete engine replacement or rebuild.

Due to the fragility of heating ducting, a diesel boiler that provides hot water to radiators via smaller and more robust water pipes may be a better option for heating sea going vessels.

If we ever have to clean up a powder extinguisher onboard again, it would be good to have some basic PPE – face mask and goggles – and, ideally, a battery vacuum onboard.

An engine check was completed, including a visual inspection of the alternator wiring, but lightly pulling each alternator cable meant I would have identified the

temperature sensor issue, if it had been broken before our departure. Also, regularly checking the alternator heat after the engine has been running is a useful check.

If we hadn't used the windlass on the motor for dropping the anchor, we would have been more relaxed about the batteries. I should have ensured the clutch was working freely before departure so the anchor could have been manually dropped quickly. Letting an anchor go without a windlass clutch requires flaking the chain out on the deck and cleating off to protect against runaway. We could and should have done this, but it would have taken time and we were keen to get the anchor down as soon as possible. A working clutch would have made it much more manageable.

A larger outboard, say 15hp, with a 3.1m tender dinghy positioned on a side tow, protected from wash on the shore side, probably could have got us into the marina unassisted if we'd gone during slack water. It was not prudent to do this with our little six hp and the prevailing conditions.

Brunsbüttel Elbe VTS couldn't have been more helpful during our sail up the Elbe; they warned us of approaching shipping and encouraged us to sail next to their busy shipping lane without hesitation. Their courtesy and professionalism were exemplary.

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