

# Lean management and “One-Piece-Flow” for PCDD/F and PCB analysis to reduce the turn-around time in smaller laboratories compared to classical batch operation

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## Introduction

There is a constant need from clients of analytical lab to reduce the turn-around time. This is even more challenging for the analysis of the 17 PCDD/F and 12 WHO-PCBs together. Smaller labs, using just one MS instrument, often think they are not able to perform PCDD/F and PCB analysis within one day having more than one sample. Lean Management and the establishment of the “One-Piece-Flow” are able to accept this challenge, with the same analytical quality and the same production costs.

## Materials and Methods

The following instruments have been used for the single steps:

- homogenisation → one Buchi Mixer B-400
  - extraction → one Dionex™ ASE™ 350
  - evaporation → two Buchi rotary evaporator R3
  - clean-up → one LCTech DEXTech Pure<sup>[1]</sup>
  - measurement → one Thermo Scientific™ DFS™ equipet with DualData-XL<sup>[2]</sup>
- All necessary steps have been recorded and the required times have been documented in Table 1.

	Registration	Homogenisation	Extraction	Evaporation	Clean-Up	Evaporation	Measurement	Data evaluation	Reporting	Total
EBT	5 min	20 min	10 min	5 min	3 min	15 min	2 min	15 min	5 min	80 min
TBT	0 min	0 min	25 min	25 min	55 min	0 min	55 min	0 min	0 min	160 min
Total BT	5 min	20 min	35 min	30 min	58 min	15 min	57 min	15 min	5 min	240 min

Table 1: Necessary time for all analytical steps (EBT → employee binding time; TBT → technical binding time; BT → binding time)

Additionally the following conditions have been defined:

- seven samples per day
- three full time employees (8h per day) qualified for all analytical steps
- opening hours 8am to 8pm

In Table 2 the “One-Piece-Flow” procedure for the seven samples incl. all QA/QC procedures is shown, considering that the two employees are working 8am to 5pm and the third employee from 12pm to 8pm.

Process\Time	8am	9am	10am	11am	12pm	1pm	2pm	3pm	4pm	5pm	6pm	7pm	8pm
Registration	①	②	③	④	⑤	⑥	⑦						
Homogenisation	①	②	③	④	⑤	⑥	⑦						
Extraction	Blank	QS	①	②	③	④	⑤	⑥	⑦				
Evaporation	Blank	QS	①	②	③	④	⑤	⑥	⑦				
Clean-up		Blank	QS	①	②	③	④	⑤	⑥	⑦			
Evaporation			Blank	QS	①	②	③	④	⑤	⑥	⑦		
Measurement	Tuning	Cal check	Toluene	Blank	QS	①	②	③	④	⑤	⑥	⑦	
Evaluation					Blank	QS	①	②	③	④	⑤	⑥	⑦
Report					Blank	QS	①	②	③	④	⑤	⑥	⑦

Table 2: Established “One-Piece-Flow” (Blank → blank sample, QS → Quality control sample, Tuning → tuning of HRMS, Cal check → calibration check injection, Toluene → Measurement blank, ① sample number one, ② sample number two, ...)

The batch operation was also done using the same conditions, manual clean-up procedure instead of DEXTech pure and one DFS without Dual Data XL. Using the batch operation procedure all seven samples have been reported on the 4<sup>th</sup> day after arrival (Table 3).

## Results

Compared to the classical batch operation procedure the “One-Piece-Flow” is capable to have results for the 17 PCDD/F and 12 WHO-PCBs ready within the same day, so three days earlier than using the classical batch operation procedure.

The fully established One-Piece-flow (see Table 2) gives the first results for PCDD/F and PCB six hours after the sample arrived and after that another result every hour until all 7 samples that have arrived the day, have been reported. Also the necessary QA procedures line the blank sample and the QC sample are covered and finished before the samples will be reported, to make sure that all results are valid.

Taking into account, that in the real world the sample appearance may vary between three and ten samples per day, this system gives the chance to buffer a variation in sample appearance, having the results for all samples arrived on one day ready latest on the following day.

Step	Registration	Homogenisation	Extraction	Evaporation	Clean-up	Evaporation	Measurement	Evaluation	Reporting
Day	1 <sup>st</sup>			2 <sup>nd</sup>			3 <sup>rd</sup>	4 <sup>th</sup>	
Finished	9am	12pm	6pm	10am	4pm	7pm	8pm	10am	12pm

Table 3: Batch operation with final time for finished steps having 7 samples analysed

## Conclusions

The here shown “One-Piece-Flow” can give smaller labs (<2000 samples for PCDD/F and PCB per year) an advantage in speed, one day instead of four days. A lab that already is equipped with one DFS, one ASE 350 and the required evaporation and homogenization tools, just need to invest in the Dual Data XL upgrade and an automated clean-up tool that is running just one sample at the time. So the change in the production cost per sample will not be significant (if any) compared to the batch operation. For larger labs (>2000 sample per year) other steps and considerations will be necessary, but also there the consequent implementation of the “One-Piece-Flow” will speed up the lab performance.

## References

[1] LCTech LCTech application note Default methods DEXTech Pure, (2018), LCTech GmbH, Obertaufkirchen

[2] Mehlmann H. MAXIMIZED PRODUCTIVITY FOR DIOXIN, PCBs and PBDE ANALYSIS USING DUALDATA MODE WITH MAGNETIC SECTOR GC-HRMS, (2018), Thermo Fisher, Bremen