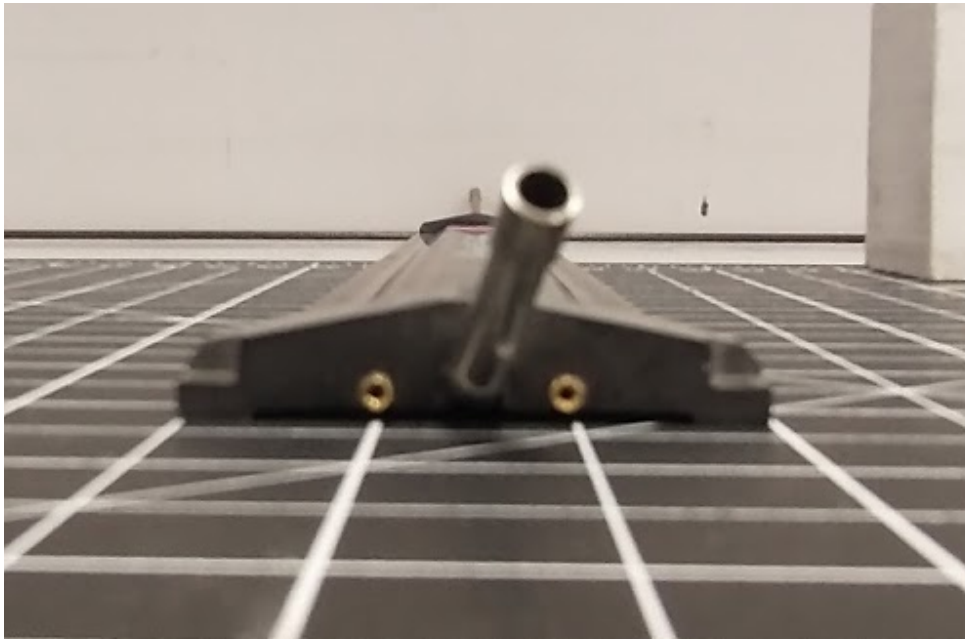
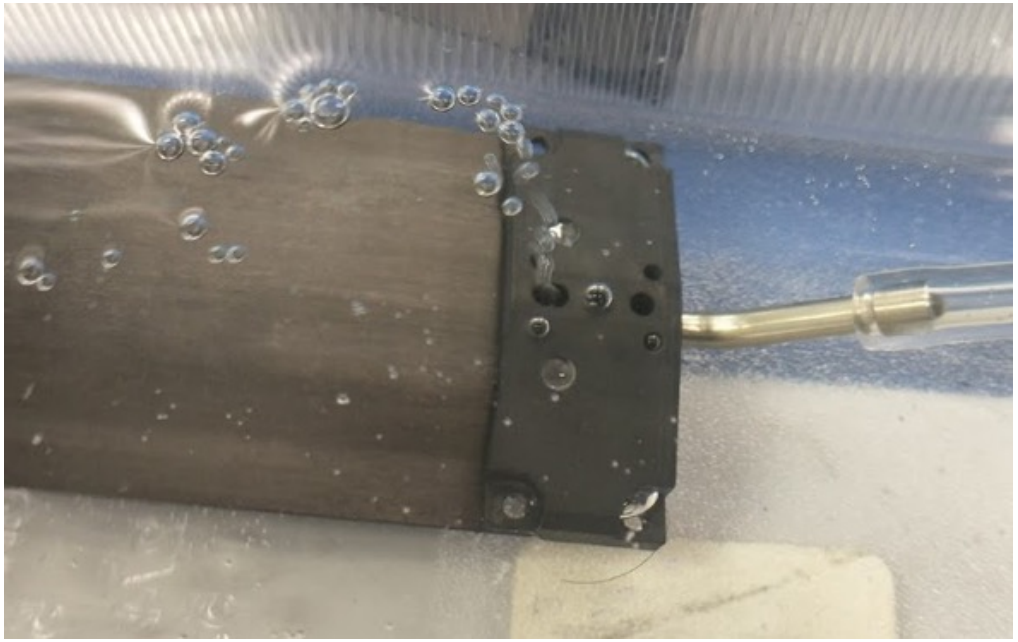
Cooling Tube Leak Issue

Possible Cause of the leak?

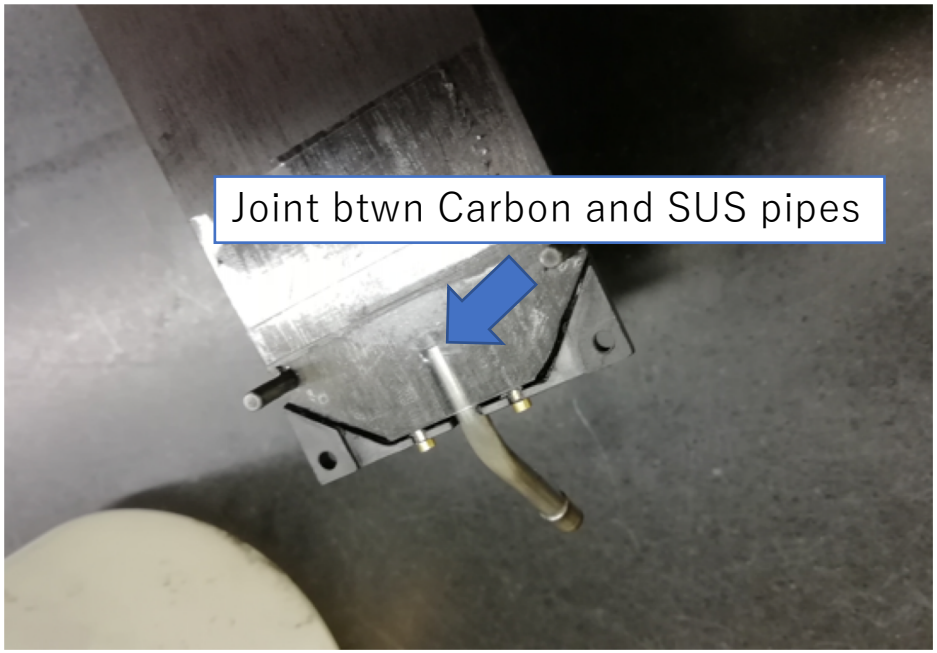
Either in the fabrication process or transportation?





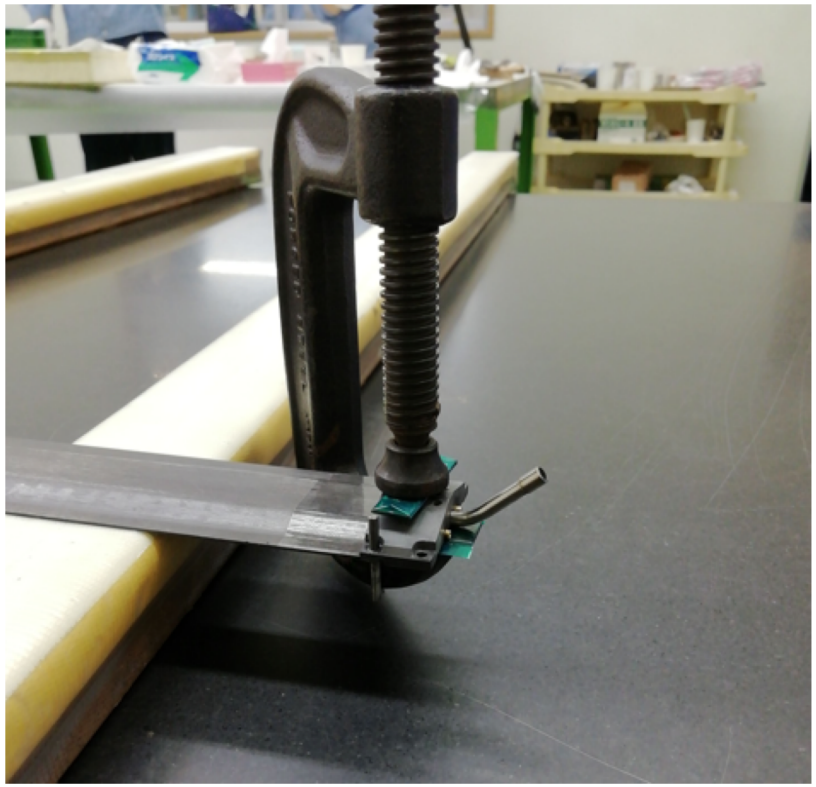
Hard to imagine this damage can happen in the fabrication process and overlooked in the final inspection before the delivery.

Possible Cause of the leak (1)?



Asuka claims it is unlikely cause because they don't squeeze the cramp too strong though, the possibility is not zero. They will take a look the leak staves to see if there is any deformation of the tube. BNL should send the leaking staves to Asuka.

Cramping the end cap after gluing PEEK for 24 hours. Possible damage in this process by squeezing the pipe.



Possible Cause of the leak(2)?

Decision

- Investigation of the cause and solution.
  1. Found relatively poor flatness of the formed CFRP plates to begin with.
  2. Repeat the oven process (80 – 100 degrees) to re-enforce better flatness after full assembly. Need parameter tune which takes time.
     - Stave flatness above 200μm certainly improved by 50μm or so, while no improvement is observed for the staves which have 150μm to begin with.
     - 5 out of 4 tubes started to leak after reheating process. We decided to give up this option.
  3. Possible excess of outer radius and straightness of cooling tubes?

Slide from Itaru's report in Nov.11, 2020

- They repeated the oven process after the assembly to re-enforce better flatness in batch-1 production for some staves.
- Tubes started leaking after this process, so they didn't employ this recovery process.
- In principle, they removed re-heated staves from the delivery staves though, these staves might be contaminated.
- They lost track of serial # of re-heated staves, but they may able to tell if they actually see the stave in their hand.

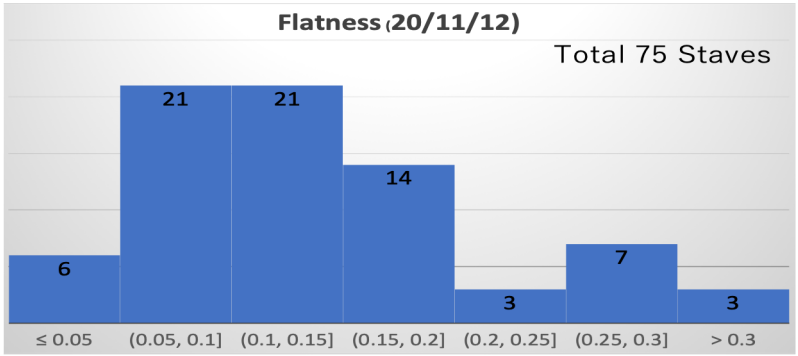
2nd Batch Stave Status

Feb. 18, 2021

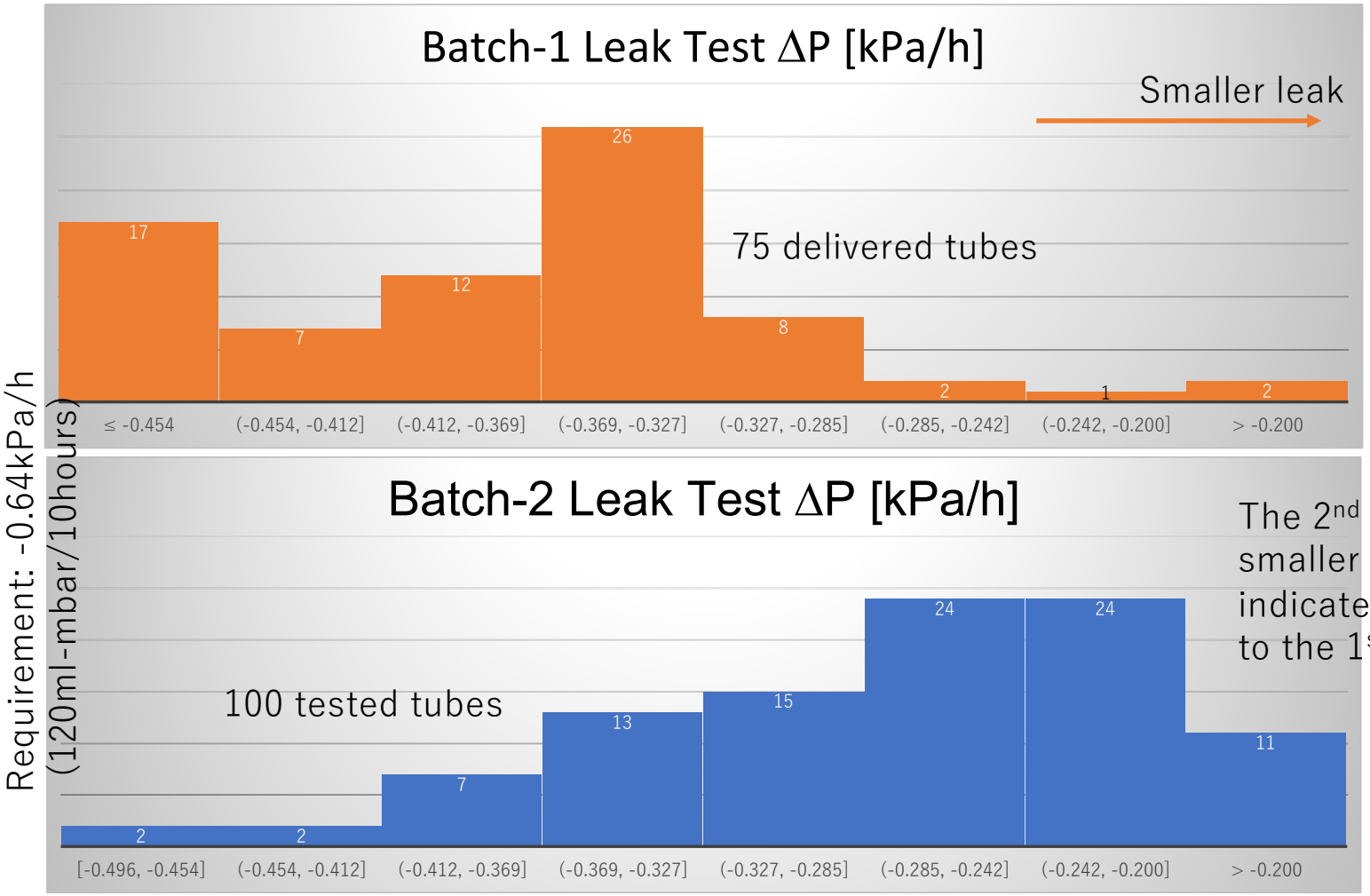
2nd Batch Stave Production Status

- Finished assembly and testing all cooling tubes. (96/100 passed the requirements).
- Completed assembly CFRP plates, rohacell, and tubes.
- 70 staves are achieved <0.1μm after this assembly. 5 more subsequent staves are have the flatness of 0.111, 0.111, 0.113, 0.119, 0.122μm.
- They are in the middle of PEEK assembly, but Itaru paused the process for now.

Batch-1 flatness



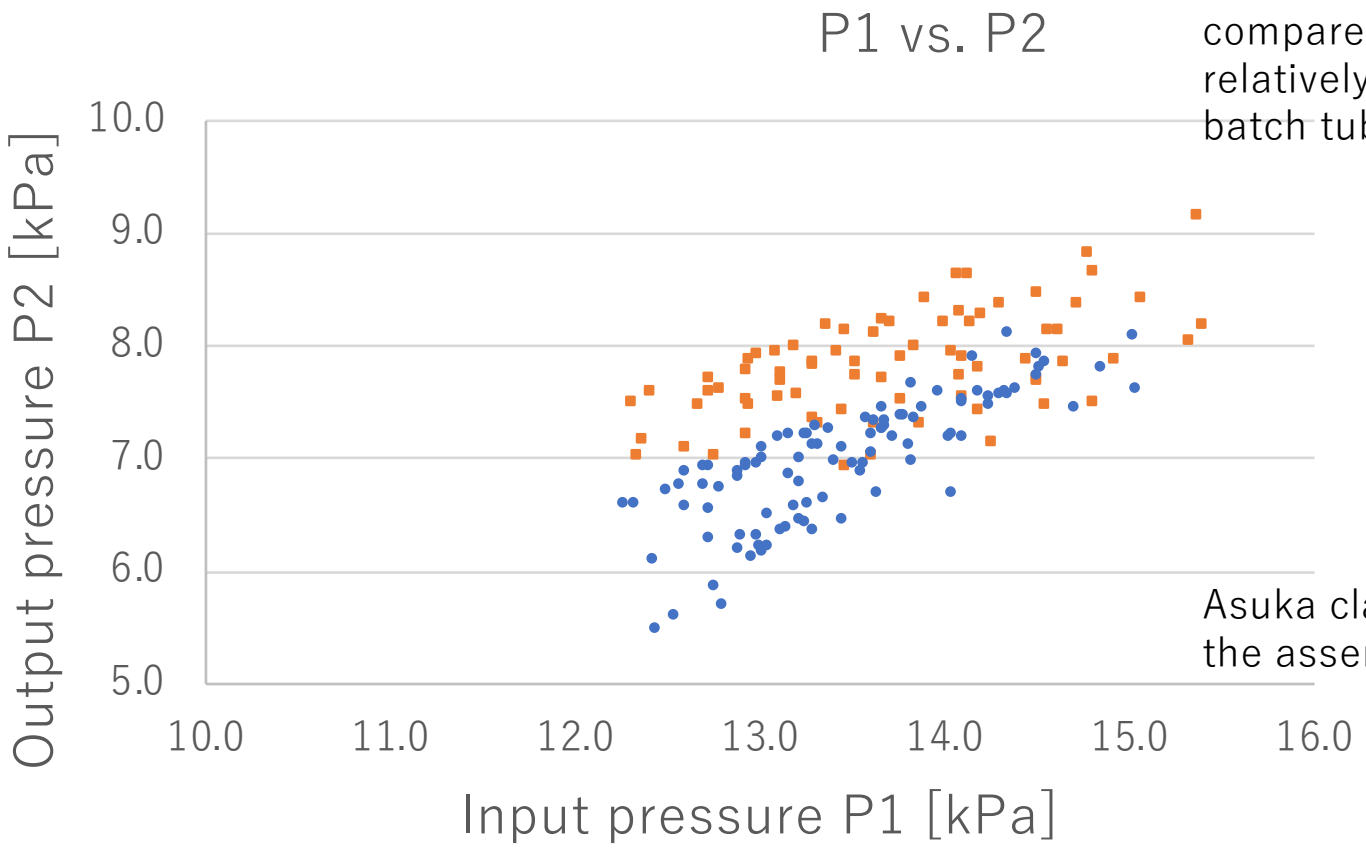
Leak Test Performance Comparison



The 2nd batch cooling tubes show smaller $|P_{t=10h} - P_{t=0}|$ tendency which indicates to have smaller leak compared to the 1st batch.

Flow Test Comparison

The water pressure gap between P1 and P2 show about 20% larger in 2nd batch compared to 1st batch. This indicates relatively larger water resistance of 2nd batch tubes.



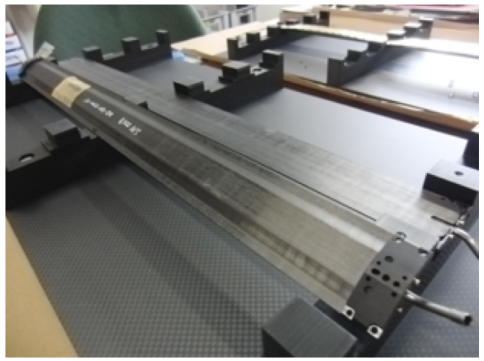
Asuka claims there is no change nether in the assembly nor the testing procedures

Other news

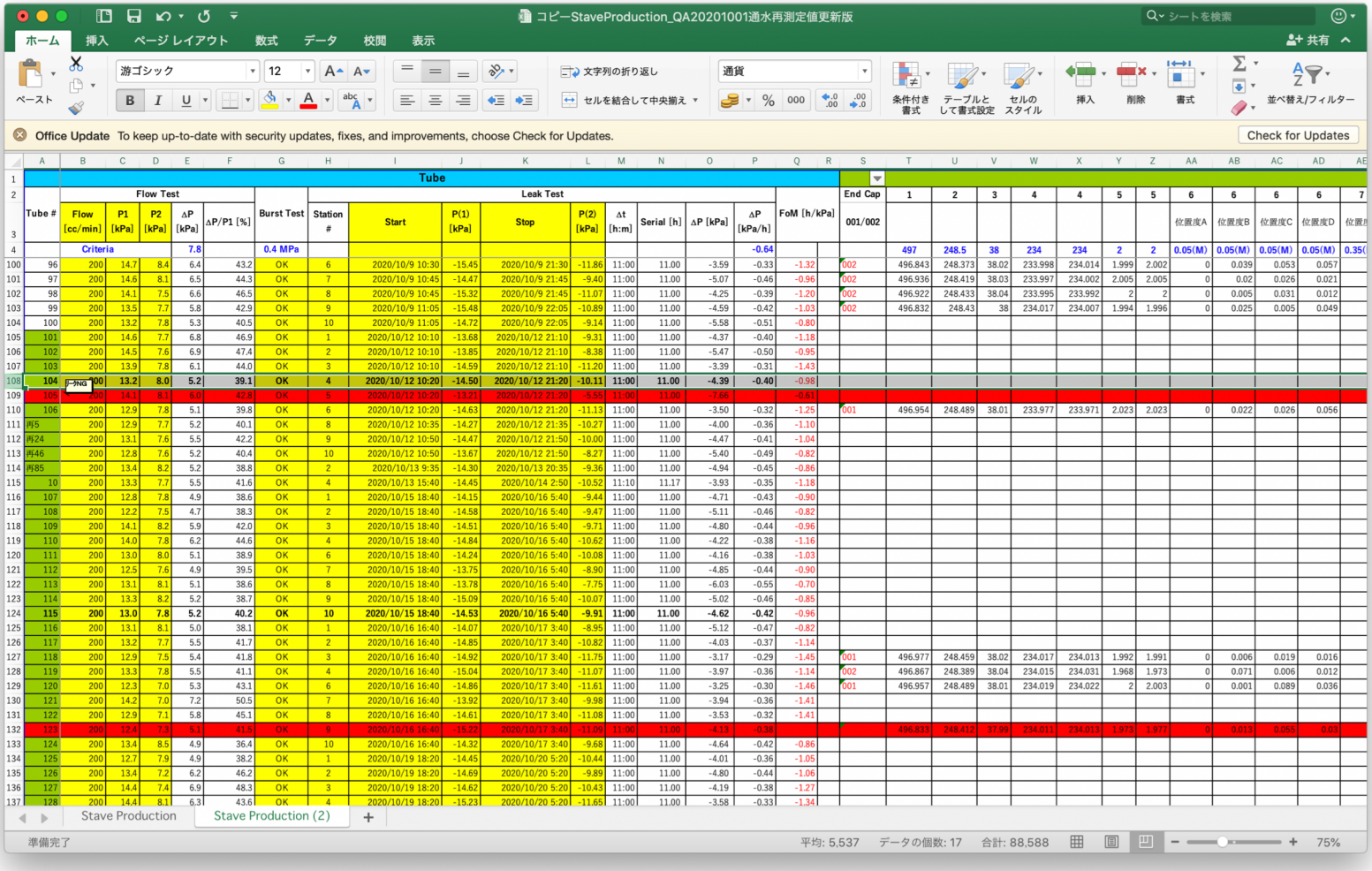
- 3 Cooling tubes (#104, 115, 181) from the 1st batch is provided from Asuka co. To be forwarded to BNL.
- Agreed to execute randomly sampled 10 staves after assembly are to be tested their leak performance again before the delivery within the present contract. They may do all stave test for the extra charge (depends on the cause).
- Transportation fixtures will cost additional $5,000 and takes a month to fabricate. This will cause delay to the 2nd batch stave delivery until middle of March instead of end of February.

Accommodates 5 staves/fixture
2nd batch 75 staves/5 = 15 fixtures
Need to fabricate 15 – 4 existing = 11 fixtures

Stave transportation fixtures



3 cooling staves to be shipped to BNL



	Tube																														
		Flow Test								Leak Test									End Cap	1	2	3	4	4	5	5	6	6	6	6	7
	Tube #	Flow [cc/min]	P1 [kPa]	P2 [kPa]	ΔP [kPa]	ΔP/P1 [%]	Burst Test	Station #	Start	P(1) [kPa]	Stop	P(2) [kPa]	Δt [h:m]	Serial [h]	ΔP [kPa]	ΔP [kPa/h]	FoM [h/kPa]		001/002								位置度A	位置度B	位置度C	位置度D	位置
		Criteria			7.8		0.4 MPa									-0.64				497	248.5	38	234	234	2	2	0.05(M)	0.05(M)	0.05(M)	0.05(M)	0.35(
100	96	200	14.7	8.4	6.4	43.2	OK	6	2020/10/9 10:30	-15.45	2020/10/9 21:30	-11.86	11:00	11.00	-3.59	-0.33	-1.32		002	496.843	248.373	38.02	233.998	234.014	1.999	2.002	0	0.039	0.053	0.057	
101	97	200	14.6	8.1	6.5	44.3	OK	7	2020/10/9 10:45	-14.47	2020/10/9 21:45	-9.40	11:00	11.00	-5.07	-0.46	-0.96		002	496.936	248.419	38.03	233.997	234.002	2.005	2.005	0	0.02	0.026	0.021	
102	98	200	14.1	7.5	6.6	46.5	OK	8	2020/10/9 10:45	-15.32	2020/10/9 21:45	-11.07	11:00	11.00	-4.25	-0.39	-1.20		002	496.922	248.433	38.04	233.995	233.992	2	2	0	0.005	0.031	0.012	
103	99	200	13.5	7.7	5.8	42.9	OK	9	2020/10/9 11:05	-15.48	2020/10/9 22:05	-10.89	11:00	11.00	-4.59	-0.42	-1.03		002	496.832	248.43	38	234.017	234.007	1.994	1.996	0	0.025	0.005	0.049	
104	100	200	13.2	7.8	5.3	40.5	OK	10	2020/10/9 11:05	-14.72	2020/10/9 22:05	-9.14	11:00	11.00	-5.58	-0.51	-0.80														
105	101	200	14.6	7.7	6.8	46.9	OK	1	2020/10/12 10:10	-13.68	2020/10/12 21:10	-9.31	11:00	11.00	-4.37	-0.40	-1.18														
106	102	200	14.5	7.6	6.9	47.4	OK	2	2020/10/12 10:10	-13.85	2020/10/12 21:10	-8.38	11:00	11.00	-5.47	-0.50	-0.95														
107	103	200	13.9	7.8	6.1	44.0	OK	3	2020/10/12 10:10	-14.59	2020/10/12 21:10	-11.20	11:00	11.00	-3.39	-0.31	-1.43														
108	104	200	13.2	8.0	5.2	39.1	OK	4	2020/10/12 10:20	-14.50	2020/10/12 21:20	-10.11	11:00	11.00	-4.39	-0.40	-0.98														
109	105	200	14.1	8.1	6.0	42.8	OK	5	2020/10/12 10:20	-13.21	2020/10/12 21:20	-5.55	11:00	11.00	-7.66		-0.61														
110	106	200	12.9	7.8	5.1	39.8	OK	6	2020/10/12 10:20	-14.63	2020/10/12 21:20	-11.13	11:00	11.00	-3.50	-0.32	-1.25		001	496.954	248.489	38.01	233.977	233.971	2.023	2.023	0	0.022	0.026	0.056	
111	内5	200	12.9	7.7	5.2	40.1	OK	8	2020/10/12 10:35	-14.27	2020/10/12 21:35	-10.27	11:00	11.00	-4.00	-0.36	-1.10														
112	内24	200	13.1	7.6	5.5	42.2	OK	9	2020/10/12 10:50	-14.47	2020/10/12 21:50	-10.00	11:00	11.00	-4.47	-0.41	-1.04														
113	内46	200	12.8	7.6	5.2	40.4	OK	10	2020/10/12 10:50	-13.67	2020/10/12 21:50	-8.27	11:00	11.00	-5.40	-0.49	-0.82														
114	内85	200	13.4	8.2	5.2	38.8	OK	2	2020/10/13 9:35	-14.30	2020/10/13 20:35	-9.36	11:00	11.00	-4.94	-0.45	-0.86														
115	10	200	13.3	7.7	5.5	41.6	OK	4	2020/10/13 15:40	-14.45	2020/10/14 2:50	-10.52	11:10	11.17	-3.93	-0.35	-1.18														
116	107	200	12.8	7.8	4.9	38.6	OK	1	2020/10/15 18:40	-14.15	2020/10/16 5:40	-9.44	11:00	11.00	-4.71	-0.43	-0.90														
117	108	200	12.2	7.5	4.7	38.3	OK	2	2020/10/15 18:40	-14.58	2020/10/16 5:40	-9.47	11:00	11.00	-5.11	-0.46	-0.82														
118	109	200	14.1	8.2	5.9	42.0	OK	3	2020/10/15 18:40	-14.51	2020/10/16 5:40	-9.71	11:00	11.00	-4.80	-0.44	-0.96														
119	110	200	14.0	7.8	6.2	44.6	OK	4	2020/10/15 18:40	-14.84	2020/10/16 5:40	-10.62	11:00	11.00	-4.22	-0.38	-1.16														
120	111	200	13.0	8.0	5.1	38.9	OK	6	2020/10/15 18:40	-14.24	2020/10/16 5:40	-10.08	11:00	11.00	-4.16	-0.38	-1.03														
121	112	200	12.5	7.6	4.9	39.5	OK	7	2020/10/15 18:40	-13.75	2020/10/16 5:40	-8.90	11:00	11.00	-4.85	-0.44	-0.90														
122	113	200	13.1	8.1	5.1	38.6	OK	8	2020/10/15 18:40	-13.78	2020/10/16 5:40	-7.75	11:00	11.00	-6.03	-0.55	-0.70														
123	114	200	13.3	8.2	5.2	38.7	OK	9	2020/10/15 18:40	-15.09	2020/10/16 5:40	-10.07	11:00	11.00	-5.02	-0.46	-0.85														
124	115	200	13.0	7.8	5.2	40.2	OK	10	2020/10/15 18:40	-14.53	2020/10/16 5:40	-9.91	11:00	11.00	-4.62	-0.42	-0.96														
125	116	200	13.1	8.1	5.0	38.1	OK	1	2020/10/16 16:40	-14.07	2020/10/17 3:40	-8.95	11:00	11.00	-5.12	-0.47	-0.82														
126	117	200	13.2	7.7	5.5	41.7	OK	2	2020/10/16 16:40	-14.85	2020/10/17 3:40	-10.82	11:00	11.00	-4.03	-0.37	-1.14														
127	118	200	12.9	7.5	5.4	41.8	OK	3	2020/10/16 16:40	-14.92	2020/10/17 3:40	-11.75	11:00	11.00	-3.17	-0.29	-1.45		001	496.977	248.459	38.02	234.017	234.013	1.992	1.991	0	0.006	0.019	0.016	
128	119	200	13.3	7.8	5.5	41.1	OK	4	2020/10/16 16:40	-15.04	2020/10/17 3:40	-11.07	11:00	11.00	-3.97	-0.36	-1.14		002	496.867	248.389	38.04	234.015	234.031	1.968	1.973	0	0.071	0.006	0.012	
129	120	200	12.3	7.0	5.3	43.1	OK	6	2020/10/16 16:40	-14.86	2020/10/17 3:40	-11.61	11:00	11.00	-3.25	-0.30	-1.46		001	496.957	248.489	38.01	234.019	234.022	2	2.003	0	0.001	0.089	0.036	
130	121	200	14.2	7.0	7.2	50.5	OK	7	2020/10/16 16:40	-13.92	2020/10/17 3:40	-9.98	11:00	11.00	-3.94	-0.36	-1.41														
131	122	200	12.9	7.1	5.8	45.1	OK	8	2020/10/16 16:40	-14.61	2020/10/17 3:40	-11.08	11:00	11.00	-3.53	-0.32	-1.41														
132	123	200	12.4	7.3	5.1	41.5	OK	9	2020/10/16 16:40	-15.22	2020/10/17 3:40	-11.09	11:00	11.00	-4.13	-0.38				496.833	248.412	37.99	234.011	234.013	1.973	1.977	0	0.013	0.055	0.03	
133	124	200	13.4	8.5	4.9	36.4	OK	10	2020/10/16 16:40	-14.32	2020/10/17 3:40	-9.68	11:00	11.00	-4.64	-0.42	-0.86														
134	125	200	12.7	7.9	4.9	38.2	OK	1	2020/10/19 18:20	-14.45	2020/10/20 5:20	-10.44	11:00	11.00	-4.01	-0.36	-1.05														
135	126	200	13.4	7.2	6.2	46.2	OK	2	2020/10/19 18:20	-14.69	2020/10/20 5:20	-9.89	11:00	11.00	-4.80	-0.44	-1.06														
136	127	200	14.4	7.4	6.9	48.3	OK	3	2020/10/19 18:20	-14.62	2020/10/20 5:20	-10.43	11:00	11.00	-4.19	-0.38	-1.27														
137	128	200	14.4	8.1	6.3	43.6	OK	4	2020/10/19 18:20	-15.23	2020/10/20 5:20	-11.65	11:00	11.00	-3.58	-0.33	-1.34														

#104, 115

3 cooling staves to be shipped to BNL

コピーStaveProduction_QA20201001通水再測定値更新版

Office Update To keep up-to-date with security updates, fixes, and improvements, choose Check for Updates.

Tube																																		
	Flow Test						Leak Test																											
Tube #	Flow [cc/min]	P1 [kPa]	P2 [kPa]	ΔP [kPa]	ΔP/P1 [%]	Burst Test	Station #	Start	P(1) [kPa]	Stop	P(2) [kPa]	Δt [h:m]	Serial [h]	ΔP [kPa]	ΔP [kPa/h]	FoM [h/kPa]		End Cap 001/002	1	2	3	4	4	5	5	6 位置度A	6 位置度B	6 位置度C	6 位置度D	7 位置
	Criteria			7.8		0.4 MPa									-0.64				497	248.5	38	234	234	2	2	0.05(M)	0.05(M)	0.05(M)	0.05(M)	0.35(
157	200	13.4	7.6	5.8	43.3	OK	7	2020/10/22 17:45	-12.44	2020/10/23 4:15	-6.76	10:30	10.50	-5.68	-0.54	-0.80														
158	200	12.7	7.5	5.2	40.9	OK	8	2020/10/22 17:45	-13.25	2020/10/23 4:15	-8.99	10:30	10.50	-4.26	-0.41	-1.01														
159	200	12.5	7.1	5.4	43.1	OK	9	2020/10/22 17:45	-13.98	2020/10/23 4:15	-9.30	10:30	10.50	-4.68	-0.45	-0.97														
160	200	13.9	7.8	6.1	43.9	OK	10	2020/10/22 17:45	-13.47	2020/10/23 4:15	-9.18	10:30	10.50	-4.29	-0.41	-1.07														
161	200	13.0	7.3	5.7	43.9	OK	1	2020/10/27 18:00	-15.03	2020/10/28 5:00	-11.08	11:00	11.00	-3.95	-0.36	-1.22														
162	200	12.5	7.1	5.4	43.5	OK	2	2020/10/27 18:00	-15.58	2020/10/28 5:00	-11.45	11:00	11.00	-4.13	-0.38	-1.16														
163	200	12.5	7.1	5.4	43.2	OK	3	2020/10/27 18:00	-15.73	2020/10/28 5:00	-12.90	11:00	11.00	-2.83	-0.26	-1.68														
164	200	13.3	7.5	5.8	43.6	OK	4	2020/10/27 18:00	-15.76	2020/10/28 5:00	-11.86	11:00	11.00	-3.90	-0.35	-1.23														
165	200	13.1	8.2	4.9	37.6	OK	6	2020/10/27 18:00	-15.08	2020/10/28 5:00	-10.73	11:00	11.00	-4.35	-0.40	-0.95														
166	200	13.4	7.9	5.5	41.2	OK	7	2020/10/27 18:00	-14.70	2020/10/28 5:00	-10.88	11:00	11.00	-3.82	-0.35	-1.19														
167	200	13.6	7.8	5.8	42.4	OK	8	2020/10/27 18:00	-15.26	2020/10/28 5:00	-11.63	11:00	11.00	-3.63	-0.33	-1.29														
168	200	13.2	7.6	5.6	42.2	OK	9	2020/10/27 18:00	-16.25	2020/10/28 5:00	-11.55	11:00	11.00	-4.70	-0.43	-0.99														
169	200	14.5	7.8	6.7	46.1	OK	10	2020/10/27 18:00	-15.43	2020/10/28 5:00	-11.95	11:00	11.00	-3.48	-0.32	-1.46														
170	200	13.2	7.9	5.3	40.3	OK						0:00	0.00	0.00	#DIV/0!	#DIV/0!														
171	200	12.8	7.7	5.2	40.3	OK						0:00	0.00	0.00	#DIV/0!	#DIV/0!														
172	200	13.4	7.7	5.7	42.5	OK						0:00	0.00	0.00	#DIV/0!	#DIV/0!														
173	200	13.9	8.0	5.9	42.7	OK						0:00	0.00	0.00	#DIV/0!	#DIV/0!														
174	200	14.2	7.7	6.5	45.9	OK						0:00	0.00	0.00	#DIV/0!	#DIV/0!														
175	200	13.5	7.6	5.9	43.8	OK						0:00	0.00	0.00	#DIV/0!	#DIV/0!														
176	200	13.1	7.8	5.3	40.8	OK						0:00	0.00	0.00	#DIV/0!	#DIV/0!														
177	200	12.6	7.8	4.8	38.1	OK						0:00	0.00	0.00	#DIV/0!	#DIV/0!														
178	200	12.8	7.7	5.1	39.6	OK						0:00	0.00	0.00	#DIV/0!	#DIV/0!														
179	200	13.2	7.9	5.2	39.8	OK						0:00	0.00	0.00	#DIV/0!	#DIV/0!														
180	200	14.2	8.1	6.0	42.5	OK						0:00	0.00	0.00	#DIV/0!	#DIV/0!														
181	**200**	**13.3**	**8.0**	**5.3**	**39.9**	**OK**	**3**	**2020/10/29 17:40**	**-15.83**	**2020/10/30 4:40**	**-11.95**	**11:00**	**11.00**	**-3.88**	**-0.35**	-1.13														
182	200	14.2	7.9	6.2	43.9	OK						0:00	0.00	0.00	#DIV/0!	#DIV/0!														
183	200	14.0	7.9	6.1	43.3	OK						0:00	0.00	0.00	#DIV/0!	#DIV/0!														
184	200	14.4	8.1	6.3	43.7	OK						0:00	0.00	0.00	#DIV/0!	#DIV/0!														
185	200	13.5	8.0	5.5	40.9	OK						0:00	0.00	0.00	#DIV/0!	#DIV/0!														
186	200	14.5	7.9	6.6	45.4	OK						0:00	0.00	0.00	#DIV/0!	#DIV/0!														
187	200	13.9	8.1	5.8	41.7	OK						0:00	0.00	0.00	#DIV/0!	#DIV/0!														
188	200	13.6	8.0	5.7	41.6	OK						0:00	0.00	0.00	#DIV/0!	#DIV/0!														
189	200	13.4	8.0	5.4	40.4	OK						0:00	0.00	0.00	#DIV/0!	#DIV/0!														
190	200	13.0	7.9	5.1	39.3	OK						0:00	0.00	0.00	#DIV/0!	#DIV/0!														
191	200	14.3	8.2	6.1	42.8	OK						0:00	0.00	0.00	#DIV/0!	#DIV/0!														
192	200	12.8	7.8	5.0	39.0	OK						0:00	0.00	0.00	#DIV/0!	#DIV/0!														
193	200	13.7	8.0	5.7	41.7	OK						0:00	0.00	0.00	#DIV/0!	#DIV/0!														
194	200	13.8	8.0	5.7	41.7	OK						0:00	0.00	0.00	#DIV/0!	#DIV/0!														

Stave Production | Stave Production (2)

準備完了 平均: 5,537 データの個数: 17 合計: 88,588 75%

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