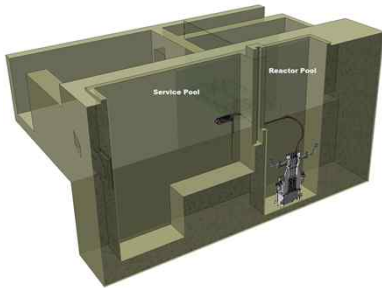# Prediction of Reaction Forces on the Hydraulic Transfer System(HTS) Supports

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· Introduction

[HTS Layout]

✓ Overview of the Hydraulic Transfer System (HTS)
- The HTS is a facility to produce radioisotopes for industrial, scientific and medical fields.
- The irradiation targets are transferred along the pipe by the hydraulic pump
- The piping is installed and supported in the reactor pool and the service pool
- The piping is classified by the seismic category II

✓ Prediction of Reaction Forces
- The structural integrity shall be checked under the SSE (Safety-Shutdown Earthquake)
- The reaction forces of the HTS supports are predicted by the response spectrum analysis
- The commercial S/W ansys 19.2 is used

· Finite Element Analysis

[Hydraulic Mass Effect]

- HTS pipes are submerged.
- Two kinds of pipes is installed.
- Density of HTS pipes is changed to consider the hydraulic mass.

	Large pipe	Small Pipe
Size	IR : 15.5 mm OR : 18.5 mm	IR : 6.92 mm OR : 10.65 mm
Pipe mass	0.8876 kg/m	0.5703 kg /m
Added mass (outer)	1.075 kg/m	0.3563 kg/m
Added mass (inner)	0.7648 kg/m	0.1504 kg/m
Total mass	2.7176 kg/m	1.0771 kg/m
Modified density	8480 kg/m^3	5231 kg/m^3

[Finite Element Analysis]

- The piping elements and the hexahedral elements are used for the pipes and supports, respectively.
- The SRSS (Square Root of the Sum of the Squares) mode combination for the response spectrum analysis is used.
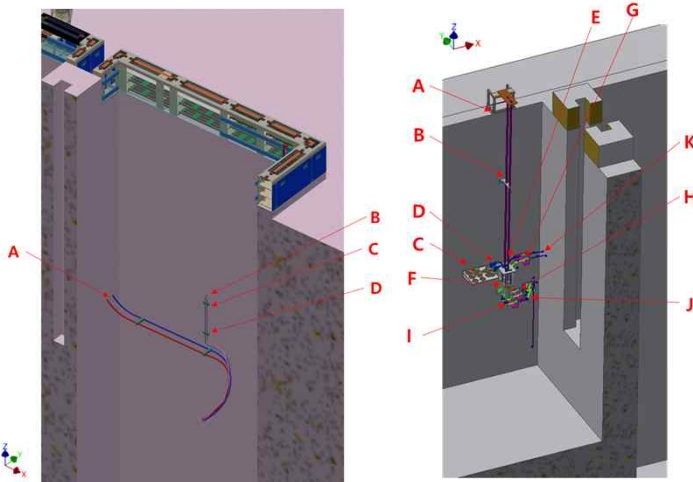
[Floor Response Spectrum]

- The FRS corresponding to the damping ratio 4 % is applied based on NUREG 1.61.
- For the conservatism, the enveloped spectrum for the horizontal directions (East-West and South-North) is generated.
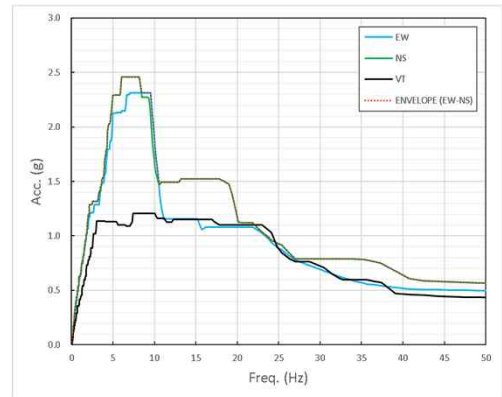
· Results and Conclusions

[Location of Reaction Forces Calculation]

[Reaction Forces of the supports in the reactor pool]

Position	F$_x$ (N)	F$_y$ (N)	F$_z$ (N)	M$_x$ (N·mm)	M$_y$ (N·mm)	M$_z$ (N·mm)
A	630	6	54	3327	-3279	7605
B	0	204	141	285	27	57
C	0	12	471	1119	1434	93
D	15	102	282	855	39030	55719

[Reaction Forces of the supports in the service pool]

Position	F$_x$ (N)	F$_y$ (N)	F$_z$ (N)	M$_x$ (N·mm)	M$_y$ (N·mm)	M$_z$ (N·mm)
A	0	-3	921	49056	5793	1578
B	-9	159	441	-4065	984	729
C	3546	288	18510	2020650	470517	1619841
D	291	252	3831	-69714	-81849	44250
E	-105	-54	3945	-67167	152469	-13227
F	195	-18	10821	-61194	19152	29250
G	0	0	1812	-163560	-36114	8073
H	0	591	2094	-203535	750	-18948
I	9	-624	1617	-107886	-25533	-1824
J	321	303	348	191295	284301	107637
K	684	-3	927	-44613	13482	156

Conclusions

✓ The reaction forces on the HTS supports are predicted when applying the seismic loading.
✓ This information is provided in order to design the embedded plates supporting the HTS components.
✓ The embedded plates shall be designed to maintain the structural integrity of the submerged HTS system.