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FWS Guidelines for Connections of Liquid Cooled ITE



NOVEMBER 9-10, 2021

Track: CE

FWS Guidelines for Connection of Liquid Cooled ITE

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GUIDELINES FOR CONNECTION OF LIQUID COOLED ITE TO DATA CENTER FACILITY SYSTEMS



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Revision 0.1

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Connecting ITE to FWS Things to Consider



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Design Considerations

- Benefits of Standardization of Connections
- Compatibility with OCP Advanced Cooling Solutions
- Pipe Diameter Standardization
- Vendor Product FWS Connection Standardization
- Dewpoint Considerations
- Leak Detection/Collection/Protection considerations
- Key Components / Functions of Connection Lines

Appendix A. Re- Connection Considerations

- **A1:** Thread Connection Considerations
- **A2:** Grooved Coupling Considerations
- **A3:** Flange Considerations

Appendix B: Fixed Connection Considerations

- **B1:** Commissioning Weld Connections
- **B2:** Commissioning Fused, Crimped Connections

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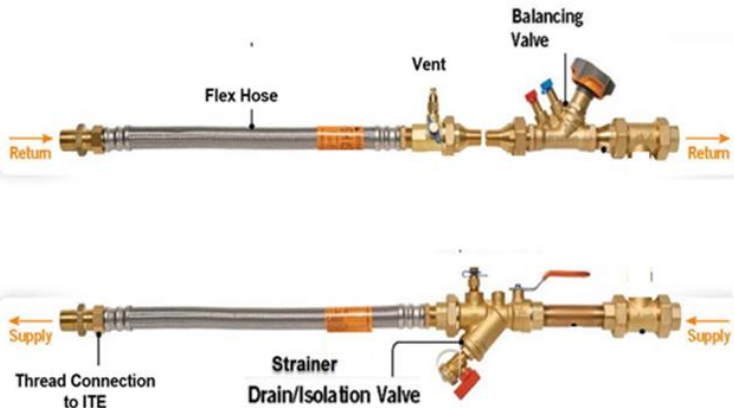
Connecting ITE to FWS

Things to Consider

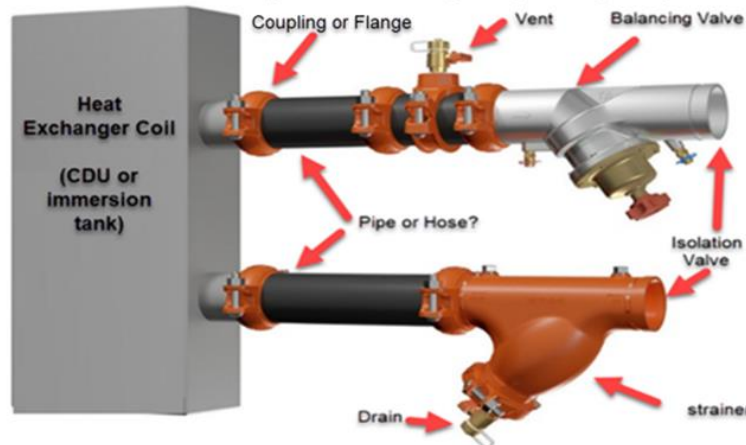


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Connection Line Example, < 2" - Balancing Valve, Isolation/Strainer, Drain, Vent



Connection Line Assembly, 2" - 8" - Balancing Valve, Strainer, Drain, Vent



- **Vent, drain ports** – Simplify exchange/maintenance of ITE and CDU. Drain ports are often incorporated with the strainer
- **Strainers** - prevent contamination of heat exchanger coils.
- **Flushing**– During initial commissioning and major system updates, pipe systems should be flushed - requires flush connections.
- **Metering points** – pressure/temp ports for dP and flow measurement. Many ITE and CDU solutions have ports included.

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Connection Leakage: Inspection Vs Protection



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Ability to Prevent Leakage by Installation Inspection

	Inspection Method to Prevent		MTBF Data	Leakage/Failure Protection Recommendation
	Leakage	Failure		
ReConnection Methods				
Threaded	None	Visual	N/A	leakage detection and protection recommended - failure unlikely
Flange	Torque check	Torque check	N/A	Leak detection/protection recommended. Re-torque verification over life of pipe of critical joints
Grooved Coupling*	Visual	Visual	>185 million hours	Auditable record of proper installation inspection required to avoid additional protection.
Fixed Connection Methods				
Weld	X-Ray	X-Ray	N/A	Record of Radiography to avoid additional protection
Crimped/pressed	???	???	N/A	Leak detection & failure protection recommended Visual inspection may provide some validation
Fused	???	???	N/A	Leak detection & failure protection recommended
Pressure test is always a requirement				
*Grooved Coupling performance based on mission critical standards of design, quality control, certified inspection process				
Pipe movement (thermal, vibration, building, seismic) can create leakage and possible separation in pipe systems if not addressed				

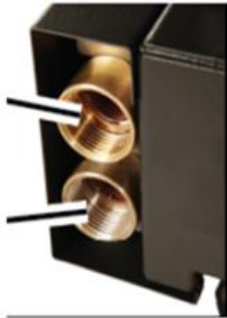
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Standardizing the FWS to ITE Connection Point



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Rack and Door Pipe Connection Thread Standards - BSPP	
1"/DN25	1.25"/DN40



Thread Connection Standardization Benefits:

- **Vendors currently standardize** on single thread type, ship adaptors as needed
- **Thread verification** is a key issue
- **Metric thread** is global and growing.
- Different thread types have **different installation methods**
- **Quick disconnects** attach via thread

Thread Installation, BSPP

- O Ring – replace each connection
- Thread tape –
 - clean threads, apply tape with each installation.
 - Ensure tape does not protrude into water flow
- Inspect for leakage on pressure test & 4 hours later

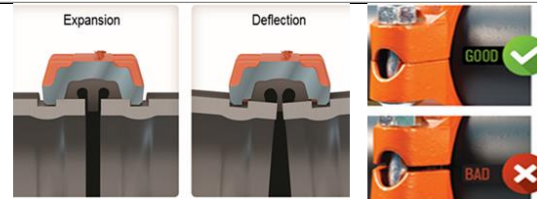
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Standardizing the FWS to ITE Connection Point



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Connections: 2"/DN50 to 8"/DN200 Class 150 Flanges Vs Mission Critical Grooved Couplings		
	Class 150 Flange	Mission Critical Coupling
Bolt Count	4 to 8 bolts	2 bolts
Alignment adjustment	none	Multi axis alignment
Movement	None, requires torque verification	design feature
Vibration Mitigation	None	design feature
Inspection method to prevent leakage	torque + pressure test; re-torque as needed	Visual inspection + pressure test = certified for life of pipe system
MTBF	N/A	>185 million hours



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Connection Guidance Workstream



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Appendix A. Re- Connection Considerations

A1: Thread Connection Considerations

A2: Grooved Coupling Considerations

A3: Flange Considerations

Appendix B: Fixed Connection Considerations

B1: Commissioning Weld Connections

B2: Commissioning Fused, Crimped Connections

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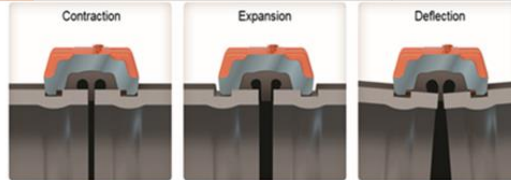
App A2 Grooved Coupling Risk Factors

Variables to Control	Potential Issue	Non failure Detection Method
Coupling not properly installed	Coupling housing must be fully engaged in groove	Visual Inspection + Pressure Test
Improper groove geometry	Coupling housing must be fully engaged in groove	Visual Inspection + Pressure Test
Pipe surface imperfections	Water seepage due to microchannels	Visual Inspection + Pressure Test



Example: Visual Verification
20+ year mission critical
performance

Alignment, Movement,
Vibration Accommodations



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App A2: Mission Critical Grooved Coupling Visual Inspection Prevents Issues



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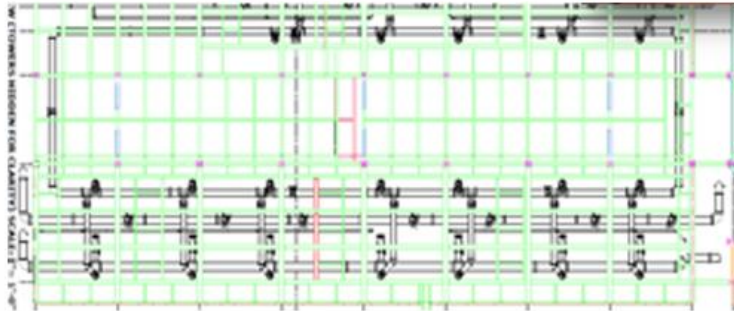


Inspection Form

Installed To Visual Standard	Proper Installation
Multi Photo	

Submit Your Inspection

Area Status	Complete
Improper Installations Pending Resolution	0
Signature	
Location / GPS	Lat: 33.0019233112551 Long: -96.723984076554
Proper Installations	36
Improper Installations	1
Inspection Count	37
Area Photo	



Proper commissioning, auditable documentation
Keys to Life of System Performance

App A3: Flange Considerations



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Key Actions, Issues to Avoid Flange Leakage

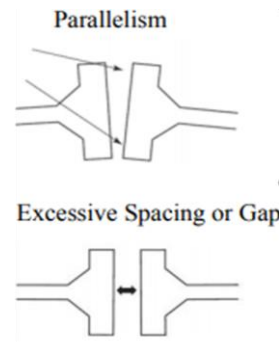
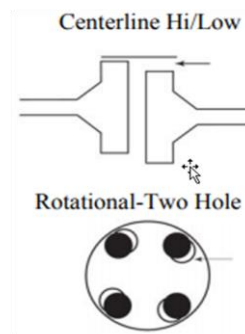
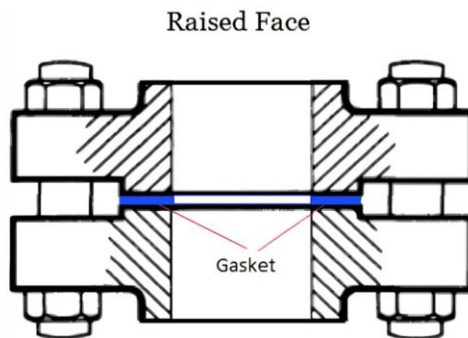
- **Alignment** - Ensuring proper alignment of joint before tightening is critical
- **Gasket Creep** - Flange gaskets typically relax after loading, within the first 4-6 hours.
- **Torque** - minimize uneven loading of gaskets, tighten bolts in a crisscross pattern. reverified after 4 hours
- **Maintenance** - Vibration, pipe movement require re-torque of bolts



Flat Face



Raised Face



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App B1: Weld Risk vs Radiography



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Weld Challenges	
Joint quality - <ul style="list-style-type: none">- internal cracking- porosity- bubble pockets- lack of fusion	
Pipe interior - slag build-up <ul style="list-style-type: none">- Flow variation- water contamination	
Heat Affected Zone - <ul style="list-style-type: none">- accelerated corrosion near weld	
Distortion, alignment stress	

**Radiography recommended
for high severity risk locations**

Weld Failure modes include:

Separation

- poor / incomplete fusion
- Cracks

**Typically discovered at pressure
test**

Accelerated corrosion

- porosities
- Regions near weld (**HAZ**)

Leaks 3-10 years after installation

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App B2: Fusion – Process Dependent

No Inspection Verification Method



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Variables to Control	Potential Issue	Detection Method
Depth of fusion section	Is pipe fully inserted into connection?	To be used in areas of elevated severity risk, fused connections should provide method to verify proper installation.
Transition Time	Connection cool down can result in incomplete insertion	
Temperature, jobsite	Affects cool down rate, heating time	
Not using enough heat	If heat time is insufficient, will not make full connection	
Cleanliness of Pipe	Incomplete fusion area (oil, dirt)	
Water contact	Any water contact on fusion area will interfere with proper fusion	
Support during Cool Down	Movement during cooling weakens bond	
Adjustment during cooldown	Twisting, adjusting alignment after 5 seconds weakens connection	Alignment verification
Mis-alignment	> 3 degrees of mis-alignment may affect bond	

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Call to Action

- Get involved in OCP Advanced Cooling Facility Sub-Project:
 - Weekly OCP ACF calls Tuesdays 1100 ET (UTC-4)
<https://global.gotomeeting.com/join/952298085>
 - https://www.opencompute.org/wiki/Data_Center_Facility/ACF-Advanced_Cooling_Facilities
- Mail List: <https://ocp-all.groups.io/g/ocp-acf>

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Open Discussion



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