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The formulae $\frac{\partial \rho \bar{U}_i}{\partial t}+\frac{\partial}{\partial x_j}(\rho \bar{U}_i \bar{U}_j)=-\frac{\partial \bar{P}}{\partial x_i}+\frac{\partial}{\partial x_j}\left(\mu \frac{\partial \bar{U}_i}{\partial x_j}\right)+g_i(\rho-\rho_0)$ *for building* $\frac{\partial}{\partial x_j}(\rho \bar{U}_i \bar{U}_j)=-\frac{\partial \bar{P}}{\partial x_i}+\frac{\partial}{\partial x_j}\left(\mu \frac{\partial \bar{U}_i}{\partial x_j}-\rho \overline{u_i' u_j'}\right)+g_i(\rho-\rho_0)$ *state of the art* $\frac{\partial}{\partial x_i}(\rho \bar{U}_i \bar{H})=\frac{\partial}{\partial x_i}\left(\lambda \frac{\partial \bar{T}}{\partial x_i}-\rho \overline{u_i' h'}\right)$ *biomedical research facilities.*

Pipe Testing Part II

The July 2019 News to Use (Part I) focused on testing of plumbing systems. This News to Use will focus on testing requirements for HVAC piping. This article is specific to pressure testing, and does not address other aspects of testing, examination, and inspection.

General Requirements

All joints shall be left uninsulated and exposed for the duration of all testing and inspections. The test period commences after the system (or section) has been completed and brought up to the full test pressure; prior to hydrostatic testing, air must be properly vented from the system. As pressure is incrementally increased, the contractor should review the system at the first step (typically 10 to 25 PSIG), after which it should be slowly brought to full test pressure under observation. The test pressure should not exceed the maximum test pressure of any component within the system, and all equipment and parts with a lower pressure rating shall be properly isolated. In all cases, the stress from pressure testing must not exceed 90% of the specified minimum yield strength or 1.7 times the SE value, per ASME B31.9. Calibrated test gauges should be ASME B40.100 Grade 1A or better and in good condition, with a face diameter of no less than 3-inches and pressure intervals $\leq$ 2 PSIG. Gauge range should be at least 1.5x the test pressure. Digital gauges may be used, provided the combined error due to calibration and reading does not exceed 0.75% of the test pressure.

Piping Systems

DRM Chapter 6 Section 6.3.9.5 provides requirements for welded piping systems, including requirements for compliance with ASME Codes (B31.9, B31.1, and by extension the ASME Boiler and Pressure Vessel Code BPVC). These codes have specific minimum requirements for weld examination; additional requirements may be necessary on a project-specific basis (example: where hot-tapping occurs) or where custom Weld Procedure Specifications (WPS) are necessary. Non-destructive testing (NDT) associated with weld examination shall be conducted **prior** to pressure testing by an AWS Certified Weld Inspector (CWI/ SCWI) or by NDT personnel qualified for the test method per SNT-TC-1A of the American Society for Non-Destructive Testing.

ASME B31.9 requires every point in the system be hydrostatically tested to 1.5 times the design pressure (or greater) for a minimum of 10 minutes. Other sections of the DRM include more stringent requirements for specific piping material and joint type applications, and in some cases compliance with ASME B31.1 or ASME B31.3 is also required. Requirements for brazed and soldered piping systems are addressed in DRM Chapter 6 Section 6.3.9.5 Sub-section C. For these types of joints, the testing procedures shall conform to ASME B31.1 and ASME BPVC.

Pneumatic Testing

ASME codes provide guidelines for pneumatic testing. However, ASME has limitations on where pneumatic testing can be used due to the inherent dangers of testing with compressed gases. Hydrostatic testing is generally preferred for ease of leak location, lower system stresses, and increased safety. Some materials (particularly some plastics) are incompatible with pneumatic testing; however, NIH has many compressed gas piping systems, and pneumatic testing can be viable for certain applications so long as it is properly and safely applied to compatible materials.

When used, pneumatic testing requires development of and adherence to a safety plan and is typically less than 1 hour in duration. Pressure is applied incrementally and shall not be raised rapidly or without allowing time for stresses of pressurization to equalize and a leak review prior to raising to the next pressure stage. Overpressure protection is required, and repeated applications of test pressure shall be avoided. Upon completion pressure should be discharged to 3 PSIG or less.

Pressure Test Duration

In DRM Chapter 8 Section 8.3.16.B, plumbing water piping systems are to be tested at 150% of the working pressure for a minimum of 4 hours. As noted above, the ASME codes related to testing of hydronic systems have a minimum test duration of 10 minutes. Due to historical issues with leakage and failures, NIH prefers that hydrostatic tests of all hydronic systems be performed for a minimum of 4 hours, and though the current DRM accepts compliance with ASME Codes, a revision to require a minimum 4-hour test duration will be issued in the near future.

Conclusion

The testing requirements referenced above are minimum requirements for these systems; project officers have the option to increase the testing requirements for any application where critical systems are being installed and / or critical facilities are at risk. Piping testing is an important factor in ensuring well installed piping systems and reducing flood risk potential at NIH.

'Design Requirements Manual (DRM) News to Use' is a monthly ORF publication featuring salient technical information that should be applied to the design of NIH biomedical research laboratories and animal facilities. NIH Project Officers, A/E's and other consultants to the NIH, who develop intramural, extramural and American Recovery and Reinvestment Act (ARRA) projects will benefit from 'News to Use'. **Please address questions or comments to:** shawm@nih.gov

Further details on this month's topic are available on the DRM website Chapters 6 and 8
https://www.orf.od.nih.gov/TechnicalResources/Pages/DesignRequirementsManual2016.aspx