
# Inspection, Testing, and Certification of Medical Gas Delivery Systems

By Richard L. Miller, CMGV

In this article, I intend to help enhance the knowledge of plumbing engineers, designers, installers, and contractors regarding the management of the construction, installation, and verification of medical gas delivery systems. I will start at the design phase of a project and move to the actual installation of the medical gas system. Then I will cover the inspection and testing to be performed by the contracting installer. Finally, I will address the verification process through release of the system to the owner for patient use.

## The Design Phase

During the early design phase, you will spend considerable time consulting with the various manufacturers of medical gas equipment to obtain their advice on the equipment available for the specific needs of the project. Top-line manufacturers also can provide a wealth of information on topics ranging from sizing and flow requirements to colors and textures that best suit the owner's tastes. The American Institute of Architects (www.aia.org) has developed and published an excellent document titled *Guidelines for Design and Construction of Healthcare Facilities.* This guide is a good source of information and is quite useful in determining the recommended number of outlets and inlets for specific patient areas. I consider the AIA *Guidelines* a must-have addition to any designer's toolkit. (This document may be a required reference by some state agencies and The Joint Commission.)

When working with medical gas delivery system design, NFPA 99: *Standard for Healthcare Facilities* is the most important document to reference. This consensus standard is developed by the National Fire Protection Association (www.nfpa.org) and has been adopted into law in all 50 states and many foreign countries. While it is true that all states do not immediately update to the most recent version of the standard, it is best to upgrade your design criteria as soon as possible. Under the chairmanship of David Mohile, the dedicated members of the Technical Committee on Piping Systems see to it that the document is updated every three years. This commitment ensures that the public has continual access to leading-edge code information on the various life support systems. This document is essential in determining the type, number, and locations of required equipment such as source systems, master alarms, area alarms, and zone valves. NFPA 99 details the requirements placed on all participants in a medical gas project, from design, installation, and inspection to testing and verification. The document also contains information of relevance for the end user. Understanding the definitions and requirements of this document will carry you a long way on all of your healthcare projects. I recommend you make yourself familiar with and utilize the most recent version available. The 2005 version is the edition in current publication, but the Technical Committee is already hard at work on the next edition. NFPA 99 covers all of the minimum design criteria required by law, and a thorough working knowledge can help prevent most, if not all, problems found during construction and after completion of a project.

Due to the criticality of the medical gas system's integrity to the life safety of patients, peer review of the design by an independent medical gas expert is always a good idea. Adding an alarm or some missed valves or relocating a zone valve at the end of a project can cost tens of thousands of dollars. This amount is multiplied dramatically if the facility's opening is delayed due to a failed inspection caused by incorrectly installed piping or equipment. A document review for code applicability can cost as little as $1,000. Some verification companies will perform the

review gratis if they are specified on the project. On many projects, the verifier is called in for the first time at the end of the project, when the walls are already closed and building managers are anxious to open the facility. However, this is not the ideal time to identify problems. Equipment required for a medical gas pipeline system usually has to be ordered, and depending on the item, the delay to opening the facility could be substantial. By consulting with a company that deals specifically with medical gas systems regularly, all parties involved in the project can avoid costly delays and inconvenience.

### Design Specification

When the medical gas system design is released for bid, the number one tool available at this stage is your design specification. It is time to pull out that old document, blow off the dust, and check to see what you really have required. If you notice a reference to NFPA 56F: *Standard for Nonflammable Medical Gas Systems* (a 20-year-old document), you know that now is a good time to update your specs. A good place to focus your efforts is found under the Extent (or Summary) of Work section of your specification.

For example, the following general notes are a good starting point:

A. This section pertains to all labor, materials, equipment, and services necessary for and incidental to the [oxygen, medical air, medical surgical vacuum, nitrogen, nitrous oxide, helium, carbon dioxide] systems as shown on the drawings and specified herein.

B. Provide source equipment, alarms, valves, outlets and inlets, piping and fittings, gauges, and all associated components and materials required for complete systems as shown on the drawings, specifications, and manufacturers' instructions as listed herein.

C. If the bulk oxygen system is supplied and installed by the owner, this contractor shall be responsible for all piping from the bulk pad and the alarm pressure switches to the facility's master alarm panels.

D. Contractor shall make all necessary connections to owner-furnished equipment.

E. Install all piping as shown on drawings, as described herein, and as described in NFPA 99, ASSE 6010, and Section 15010—Basic Mechanical Requirements, using materials and methods of fabrication, grading, testing, repairing, cleaning, and other procedures as described.

F. High-voltage electrical wiring for ceiling columns, alarms, vacuum pump, air compressor, manifolds, and modular accessories associated with the systems shall be part of the electrical contract. Any equipment supplied by the mechanical/plumbing contractor that requires additional electrical services other than the specified products shall be the responsibility of the mechanical/plumbing contractor to supply these services.

G. Retain qualified installers (ASSE 6010 qualified) as specified and per NFPA 99 (2005). The installing company shall be pre-qualified.

H. Retain a qualified third-party verifier (MGPHO credentialed and ASSE 6030 qualified) as specified herein and per NFPA 99 (2005). The verifier shall be acceptable to the engineer and owner to perform and attest to final verification of the systems. If items or areas of nonconformance are noted, the installer or manufacturer shall make corrections as required, and the verifier shall periodically check with the contractor during installation of the pipeline systems' equipment and perform additional testing if necessary to attain acceptable certification. Refer to the allowance for retesting of nonconformance items or areas. The verification company shall be preapproved equal.

I. Related work and materials are specified in Section 15010—Basic Mechanical Requirements and other sections of this division.

J. Finished medical gas and vacuum systems shall be complete, fully tested, compliant with NFPA 99 (2005) in every material respect, and ready to be put into operation. All materials used shall be new and comply with NFPA 99 (2005) requirements for materials, and workmanship shall be first class in every respect. Contractor shall be responsible for compliance with all local, state, or federal codes.

K. Manufacturer shall have a product specialist available to periodically check with the contractor during installation of the pipeline systems' equipment and a separate service organization (as part of the same manufacturer's company, verification company, or pre-qualified) to start up the systems and provide ongoing service support to the facility after turnover to the owner. The service center shall be pre-qualified.

Your specification also should clearly define the credentialing requirements for American Society of Sanitary Engineering (ASSE) 6010 medical gas system installers, ASSE 6015 bulk medical gas system installers, ASSE 6020 medical gas system inspectors, and ASSE 6030 medical gas verifiers.

Wait a minute, some of you are saying. What is this ASSE 6000: *Professional Qualifications Standard for Medical Gas Systems Personnel*? Actually, it is one of the best tools that has been provided to our profession in years. Many existing specifications address skill sets of the various trades by using words like "qualified," "competent," or "experienced." All of these qualifiers are vague and defy quantification, and this type of language is not enforceable. In some cases, companies started projects with one licensed tradesman in each discipline and then hired anyone they could find to perform the work. The pace of construction we are experiencing these days does not allow us the luxury of time to redo substandard work. Normally, the only way to rectify improperly installed

medical gas piping is to replace it, a costly and laborious process to which no one would look forward.

Under the direction of Shannon Corcoran, ASSE (www.asse-plumbing.org), with the help of a very experienced and dedicated working group, has developed a standardized set of professional qualifications for installers, inspectors, and verifiers of medical gas delivery systems. Your specification can require all installers, inspectors, and verifiers of medical gas delivery systems on your project to hold a credential meeting the minimum requirements of ASSE 6000. You now have available some very specific quality control procedures that govern the installers, inspectors, and verifiers of these vital life support systems, which may help you hear fewer comments such as "I only did what was on the plans" or "We were just doing the best we knew how."

When we teach and credential people to national standards, we help develop partners in the process. NFPA 99 requires all installers and verifiers to obtain ASSE 6000 series training and credentialing. Courses are available nationwide. Another partner that should be involved much earlier in the process is a Medical Gas Professional Healthcare Organization (MGPHO [www.mgpho.org]) Credentialed Medical Gas Verifier (CMGV [more on this later in the article]).

## The Inspection Phase

Let's move on to the inspection phase. When should it start? At a certain percentage of completion? A better place would be to start this process at the construction kickoff meetings. This is the time to involve your partners and to set some ground rules to help define individual responsibilities.

I might be biased because I am a medical gas system inspector and verifier, but involving someone with many years of experience in medical gas system applications at the initial stages of a project can be quite useful. When it comes to inspections, the ASSE 6020 standard addresses the qualifications of a medical gas system inspector. Many designers and project managers have been attending medical gas inspector seminars to enhance their understanding of the inspection and code process.

The NFPA 99 standard is also quite useful in guiding you through some of the administrative requirements, such as the requirement for a log book containing site observation records and test results. Test and inspection reports are required as the project progresses. The inspector shall personally witness the various tests and record the results of the tests performed by the installer. The medical gas inspector shall confirm that proper materials and joining methods are used, materials and supports are properly handled and installed, and the correct purge procedure and appropriate labeling and identification are used. The inspector also will verify that the appropriate documents are maintained on the jobsite. Some of these include:

- Building permits
- Shop drawings
- Manufacturers' literature and test documentation
- Cleaned for oxygen service documentation on tubing and fittings
- Brazing qualification records and brazing alloy documentation
- Test gas purity
- Brazing procedure specification and brazer performance qualification records

Finally, you should have copies of the credentials and liability insurance for all ASSE 6010 installers, ASSE 6015 bulk gas installers, ASSE 6020 inspectors, and ASSE 6030 verifiers.

On-site inspections also should include visual inspection of brazed joints and a random sampling of completed joints (destructive testing). The following contractor-required tests should be witnessed and thoroughly documented:

- Initial blow down
- Initial pressure test
- Cross-connection tests
- Standing pressure tests (24-hour)
- Final purge tests

At this point, the work should be ready for final verification.

## Verification

It is now time for the verifier of record to perform his magic. Wait a minute, magic? What is it exactly that the verifier is supposed to do? Is anybody really sure, beyond the fact that they are supposed to perform some kind of test and develop a document that states that the systems are okay?

NFPA 99 (2005) Section 5.1.12.1.1 very clearly spells out what is required of the verifier. "Inspection and testing shall be performed on all new piped gas systems, additions, renovations, temporary installations, or repaired systems to assure the facility, by a documented procedure, that all applicable provisions of the document have been adhered to and system integrity has been achieved or maintained."

Wow, that paragraph is really a mouthful, but the mandate is quite clear: the verifier is to inspect, test, and develop a document that proves that the installation meets all current code requirements and that it is safe and ready for patient use. I think that is a rather large responsibility—kind of like what designers must live up to every day. So where do you find somebody with this knowledge and experience to participate in your project?

Historically, you accepted whomever the mechanical contractor wanted to use (isn't that a conflict of interest?), or in many cases, the medical gas certifier was hired independently by the hospital or general contractor. Now, however, the ASSE standard works for you in

this area as well. If you require the verifier to meet the requirements for an ASSE 6030 or an MGPHO CMGV, you have taken a step in the right direction.

At this time, I want to explain more about MGPHO, which is a professional group dedicated to the safety and advancement of medical gas delivery systems. The group's members include people from all facets of our industry, such as designers, manufacturers, healthcare personnel, and verifiers. The MGPHO CMGV designation is the highest and most widely accepted credential in the medical gas system verification industry. If you specify an MGPHO CMGV on your projects, you will have the resources of the entire organization behind you. The MGPHO website includes a U.S. map that will help you find a credentialed verifier in your area, as well as an excellent forum. You will find medical gas discussions conducted around the clock. There is no better place to find unbiased answers to your medical gas questions. MGPHO members are involved in legislative and code issues all around the world. We currently are lobbying designers, project managers, and hospital owners to specify or contract MGPHO CMGV verifiers to help alleviate some past conflicts of interest.

In addition to ensuring that the systems meet the minimum requirements, the verifier will check all source equipment for form and function. Next, he will test all alarm systems for set points, signals, and pressures monitored. Function and location of all valves in the system are documented to help the owner log the controls. Piping systems are tested for purity, for both gaseous and particulate contaminants. The final tests confirm form, fit, and function of all medical gas outlets and inlets.

The collected information then is assembled into a document for approval by the authority having jurisdiction. Once the owner has performed their tests and the certificate of occupancy has been issued, the team can move on to the next project. Hope to see you there. PSD

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