

Safe Hot Tapping Practices in the Petroleum and Petrochemical Industries

API RECOMMENDED PRACTICE 2201
FIFTH EDITION, JULY 2003

REAFFIRMED, MARCH 2020



AMERICAN PETROLEUM INSTITUTE

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Downstream Segment

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FOREWORD

This publication is designed to provide a better understanding of the problems and hazards encountered when installing hot tap connections on piping, vessels or tanks containing flammable or combustible liquids or gases. The essential elements of this publication are based on accumulated knowledge and experience of the petroleum industry, current industry safe operating practices, and existing consensus standards. The practices described in this publication are designed to protect the safety of personnel and the facilities for the work involved. It shall be noted, however, that special problems beyond the scope of this publication are possible. Also, federal, state and local regulations or laws may contain additional requirements that must be taken into account when a hot tap program is developed for a specific facility.

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Safe Hot Tapping Practices in the Petroleum & Petrochemical Industries

SECTION 1—GENERAL

1.1 PURPOSE

This publication provides information to assist in safely conducting hot tapping operations on equipment in service in the petroleum and petrochemical industries. No document can address all situations nor answer all potential questions. However, the understanding of potential hazards, and application of this knowledge, can help reduce the probability and severity of incidents.

1.2 SCOPE

Hot tapping is the technique of attaching a welded branch fitting to piping or equipment in service, and then creating an opening in that piping or equipment by drilling or cutting a portion of the piping or equipment within the attached fitting. (In certain specific situations a bolted or mechanical fitting may be used. This approach is not common practice in oil processing and petrochemical facilities and this document does not address any considerations unique to “hot tapping without welding”.) Hot tapping is usually performed when it is not feasible, or is impractical, to take the equipment or piping out of service, or to purge or clean it by conventional methods. With proper review to determine that a hot tap is appropriate, and development and conformance to job-specific procedures, many hot tap connections have been safely made without interfering with the process operation.

This publication covers the safety aspects to be considered before and during hot tapping on in-service piping or equipment. It provides:

- aids to recognize, review, and address safety concerns;
- a review of potential hot tapping concerns based on industry experience;
- guidance on planning hot taps;
- application of “hazard versus risk” concepts applied to hot tapping;
- elements to consider during the hot tap process from job analysis through completion;
- suggestions on “what to do if things go wrong.”

This publication is not:

- a substitute for job-specific planning;
- a set of work procedures.

Virtually every hot tapping job is different. A detailed, written, job-specific hot tap procedure should be available before starting each job to help ensure that appropriate measures are addressed. If there are standing procedures for hot tapping they should be reviewed for applicability to the specific job to be done. These procedures may need revision in

response to unique job specific problems or situations that may arise concerning the safety of personnel and facilities.

The hot tap approach described in this publication applies to piping and equipment fabricated from ferritic and austenitic steel. Other materials, such as aluminum, copper, plastic, and cast iron may be unsuitable for hot tapping or welding or may require special procedures.

Hot tapping is a “change” subject to review based on facility “management of change” processes or procedures.

1.3 RETROACTIVITY

Any provisions in this publication related to design are intended for reference when designing new facilities or when considering major revisions or expansions, or establishing new programs. It is not intended that any recommendations in this publication be applied retroactively to work performed at existing facilities. This recommended practice should provide useful guidance when there is a desire or need to review procedures, programs or facilities.

1.4 CONCEPT OF HAZARD VS. RISK

Hazards are properties of materials with the inherent ability to cause harm. Flammability, toxicity, corrosivity, stored chemical or mechanical energy all are hazards associated with various industrial materials. Risk requires exposure. A hot surface or material can cause thermal skin burns or a corrosive acid can cause chemical skin burns, but these can occur only if there is contact exposure to skin. There is no risk when there is no potential for exposure.

Determining the level of risk involves estimating the probability and severity of exposure that could lead to harm. While the preceding examples relate hazards to the risk to people, the same principles are valid for evaluating property risk. For instance, hydrocarbon vapors in a flammable mixture with air can ignite if exposed to a source of ignition resulting in a fire which could damage property.

1.5 CONCEPT OF COMPETENT AND QUALIFIED PERSONS

OSHA uses the term “competent person” in dozens of standards for persons serving a variety of roles. In other standards the term “qualified person” is used. Sometimes both terms are used in the same standard. This recommended practice also uses these terms. The following sections explain this usage. In both cases it is the employer who has the responsibility for designating the person.

Essentially the decision of who is a “competent person” or a “qualified person” becomes a performance oriented management decision, evaluating varied experience, skills and knowledge needed for each category.

1.5.1 Competent Person

The concept of relying on the experience and judgement of a “competent person” is used in this document as it is in many standards and regulations. In street terms this means “someone who knows enough to make the right decisions to do a job properly”. One definition [from 1926.32(f)] says a competent person “means one who is capable of identifying existing and predictable hazards in the surroundings or working conditions which are unsanitary, hazardous, or dangerous to employees, and who has authorization to take prompt corrective measures to eliminate them.”. In other standards the requirements to qualify as a “competent person” are expanded to include training in subject specific courses defined by OSHA or EPA. This document does not specify training requirements or courses.

1.5.2 Qualified Person

The concept of “qualified person” implies knowledge or education (which may be technical) beyond, or different from, that of a competent person. One definition describes a qualified person as “one who, by possession of a recognized degree, certificate, or professional standing, or who by extensive knowledge, training and experience, has successfully demonstrated ability to solve or resolve problems relating to the subject matter, the work, or the project.”

For craft personnel, an OSHA formal interpretation puts the burden on the employer, stating “OSHA does not require tests to assess craft technical skills and knowledge. It is the responsibility of the employer to assure that their employees possess the skills and knowledge necessary to perform their tasks safely.” Facility or regulatory requirements may require welders to perform certain tests to qualify as a “code welder,” but the mandatory need for this qualification may be restricted to work on specific equipment; it may, or may not, be relevant to hot tap work depending on the equipment being hot tapped.

For engineers a “qualified person” may be characterized as having relevant education, experience and specialized knowledge for the specific subject or activity.

SECTION 2—REFERENCED PUBLICATIONS

The latest editions of the following documents are referenced in this publication:

API

RP 12R1	<i>Setting, Maintenance, Inspection, Operation and Repair of Tanks in Production Service</i>
Std 510	<i>Pressure Vessel Inspection Code: Maintenance Inspection, Rating, Repair, and Alteration</i>
Std 570	<i>Piping Inspection Code: Inspection, Repair; Alteration, and Rerating of In-Service Piping Systems</i>
RP 582	<i>Welding Guidelines for the Chemical, Oil, and Gas Industries</i>
Std 598	<i>Valve inspection and Testing</i>
Std 650	<i>Welded Steel Tanks for Oil Storage</i>
Std 653	<i>Tank Inspection, Repair Alteration, and Reconstruction</i>
RP 750	<i>Management of Process Hazards</i>
Publ 941	<i>Steels for Hydrogen Service at Elevated Temperatures and Pressures in Petroleum Refineries and Petrochemical Plants</i>
Std 1104	<i>Welding of Pipelines and Related Facilities</i>
RP 1107	<i>Pipeline Maintenance Welding Practices</i>

RP 2009	<i>Safe Welding, Cutting, and Hot Work Practices in the Petroleum and Petrochemical Industries</i>
Std 2015	<i>Safe Entry and Cleaning of Petroleum Storage Tanks</i>
RP 2016	<i>Recommended Practice for Entering and Cleaning Petroleum Storage Tanks</i>
Publ 2216	<i>Ignition Risk of Hydrocarbon Vapors by Hot Surfaces in the Open Air</i>
ACGIH ¹	<i>Threshold Limit Values for Chemical Substances and Physical Agents In the Work Environment and Biological Exposure Indices</i>
ANSI ²	
Z49.1	<i>Safety in Welding, Cutting and Allied Processes (ANSI/AWS)</i>
Z244	<i>Lockout/Tagout of Energy Sources (ANSI/NSC)</i>

¹American Conference of Governmental Industrial Hygienists, 6500 Glenway Avenue, Building D-5, Cincinnati, Ohio 45211. www.acgih.org

²American National Standards Institute, 1430 Broadway, New York, New York 10018. www.ansi.org

ASME ³		NFPA ⁹	
ASME Boiler and Pressure Vessel Code		51B	Standard for Fire Prevention During Welding, Cutting, and Other Hot Work
Section VIII “Pressure Vessels”			
Section IX “Welding & Brazing Qualifications”		NIOSH ¹⁰	
B3 1.3 Chemical Plant and Petroleum Refinery Piping		Pub 88-110	Criteria for a Recommended Standard: Welding, Brazing, and Thermal Cutting
B31.4 A Liquid Transportation Systems for Hydrocarbons, LPG, etc.		Pub 99-115	Pocket Guide to Chemical Hazards and Other Databases (CD-ROM)
B31.8 Gas Transmission Pipelines		U.S. DOT ¹¹	
ASSE ⁴		49 Code of Federal Regulations Parts 190 – 199	
Guidelines for Hot Work in Confined Spaces; Martin H. Finkel, CIH, CMC ASSE Press 1999		192.55	Welded Branch Connections
		192.151	Tapping
		192.627	Tapping Pipelines Under Pressure
AWS ⁵		U.S. OSHA ¹²	
F 3.1 Guide for Welding Fume Control		29 Code of Federal Regulations Parts 1910 and 1926	
Battelle Institute ⁶		1910.119	Process Safety Management of Highly Hazardous Chemicals
Investigation and Prediction of Cooling Rates During Pipeline Maintenance Welding and Battelle’s Hot Tap Thermal Analysis Models		1910.146	Permit-Required Confined Spaces
		1910.147	Control of Hazardous Energy (Lockout/Tagout)
Edison Welding Institute ⁷		1910.251-7	Subpart Q Welding, Cutting, and Brazing (and following) Subpart Z, “Toxic and Hazardous Substances”
Project J6176 Qualification And Selection Of Procedures for Welding Onto In-Service Pipelines and Piping Systems		1910.1000	Hazard Communication
		1910.1200	Definitions (for OSHA Construction Standards)
National Board ⁸		1926.32	Gas Welding and Cutting
ANSI/NB-23 National Board Inspection Code		1926.350	Welding, Cutting, and Heating in Way of Preservative Coatings
		1926.354	

³American Society of Mechanical Engineers, 345 E. 47th Street, New York, New York 10018. www.asme.org

⁴American Society of Safety Engineers, 1800 E. Oakton Street, Des Plaines, Illinois 60018. www.asse.org

⁵American Welding Society, 550 N.W. LeJeune Road, Miami, Florida 33126. www.aws.org

⁶Joe Sheldrick, Publisher, Battelle Press Bookstore, 505 King Avenue, Columbus, Ohio 43201-2693. www.battelle.org

⁷Edison Welding Institute, 1100 Kinnear Road, Columbus, Ohio 43212. www.ewi.org

⁸National Board of Boiler and Pressure Vessel Inspectors, 1055 Crupper Avenue, Columbus, Ohio 43229. www.nationalboard.org

⁹National Fire Protection Association, Batterymarch Park, Quincy, Massachusetts 02269. www.nfpa.org

¹⁰National Institute for Occupational Safety and Health (NIOSH) Centers for Disease Control and Prevention (CDC) NIOSH/CDC, 4676 Columbia Parkway, Cincinnati, Ohio 45226. www.cdc.gov/niosh

¹¹U.S. Department of Transportation, 400 7th Street, S.W. Washington, D.C. 20590. www.dot.gov

¹²U.S. Department of Labor, Occupational Safety and Health Administration, 200 Constitution Ave., N.W., Washington, D.C. 20210. (OSHA Regulations are posted on, and can be downloaded from, the OSHA web site.) www.osha.gov

SECTION 3—DEFINITIONS

3.1 acute hazard: Capable of causing effects occurring from exposure over a short time, usually a few minutes or hours. An acute exposure can result in short-term or long-term health effects.

3.2 chronic health hazard: Capable of causing effects occurring from exposure over a long period of time (often at low-level concentrations).

3.3 competent person: A person identified by the employer as being capable of identifying existing and predictable hazards in the surroundings or working conditions which

are unsanitary, hazardous, or dangerous to personnel, and who has authorization to take prompt corrective measures to eliminate them. (OSHA 1926.32) The concept of “competent person” is performance based and relative to the context of the work to be done. (see 1.5.1)

3.4 confined space: An enclosure with known or potential hazards and restricted means of entrance and exit, which is not normally occupied by people, and is usually not well ventilated. Examples of confined spaces in the petroleum industry include: process vessels, vessel tower skirts, flare stacks, boiler

ers, storage tanks, tank cars and trucks, vaults, large-diameter piping, and under certain circumstances, spaces located below ground level, such as pits. (OSHA 1910.146).

3.5 exposure limit: For chemical agents are a measure of the maximum airborne concentration limits for toxic substances to which workers may be exposed without protection (for example, respirators). Exposure limits are usually expressed in parts per million or milligrams per cubic meter for a defined period of time. Material Safety Data Sheets (MSDSs) from the manufacturer or supplier of the material should list exposure limits.

3.6 hot tapping: The technique of attaching a mechanical or welded branch fitting to piping or equipment in service, and creating an opening in that piping or equipment by drilling or cutting a portion of the piping or equipment within the attached fitting.

3.7 hot work: An operation that can produce heat from flame, spark or other source of ignition with sufficient energy to ignite flammable vapors, gases, or dust. Hot work includes such things as electric arc and gas welding, chipping, flaming, grinding, cutting, abrasive blasting, brazing and soldering. Special procedures and permits are required when hot work is to be performed in certain areas. (Appendix D of ANSI Z49.1 lists more than 90 welding and allied processes that can qualify as "hot work").

3.8 hydrogen blister: Bulge in steel caused by high pressure molecular hydrogen trapped at an internal flaw within steel.

3.9 IDLH: The NIOSH traditional definition is the maximum concentration of an air contaminant from which one could escape within 30 min. without a respirator and without experiencing any escape-impairing or irreversible health effects.

3.10 inerting: The process of eliminating the potential for a flammable atmosphere by using an inert gas such as nitrogen, carbon dioxide or steam (water vapor) to displace oxygen required for ignition.

3.11 lockout: "The placement of a lockout device on an energy isolating device, in accordance with an established procedure, ensuring that the energy isolating device and the equipment being controlled cannot be operated until the lockout device is removed" (from OSHA 1910.147).

3.12 lockout/tagout: Use of either a lockout or tagout procedure conforming to OSHA 1910.147.

3.13 lower flammable limit (LFL): The minimum concentration of a vapor in air (or other oxidant) below which propagation of flame does not occur on contact with an ignition source. The lower flammable limit is usually expressed as a volume percentage of the vapor in air. Sometimes called Lower Explosive Limit (LEL).

3.14 particulate: Inhalable materials considered by ACGIH to be hazardous when deposited anywhere in the respiratory tract.

3.15 permissible exposure limits (PELs): Federal workplace chemical exposure regulations set by the Occupational Safety and Health Administration, U.S. Department of Labor, and found at 29 *Code of Federal Regulations* 1910.1000 and in the substance-specific standards which follow.

3.16 permit: A written document authorizing a work activity and defining the conditions under which the work shall be conducted. Normally signed by both the recipient and an issuing competent person with authority to allow the activity to take place.

3.17 personal protective equipment (PPE): Equipment (such as protective clothing, respiratory devices, protective shields or barriers) worn or used by individuals to protect eyes, face, head and extremities.

3.18 qualified person: A person designated by the employer who, by possession of a recognized degree, certificate, or professional standing, or by extensive knowledge, training and experience, has successfully demonstrated ability to identify and solve or resolve problems relating to the subject matter, the work, or the project and, when required, is properly licensed in accordance with federal, state, or local laws and regulations. (see 1.5.2)

3.19 risk: The probability of exposure to a hazard which could result in harm to personnel, the environment or general public.

3.20 risk assessment: The identification and analysis, either qualitative or quantitative, of the likelihood and outcome of specific events or scenarios with judgements of probability and consequences.

3.21 risk-based analysis: A review of potential needs based on a risk assessment.

3.22 tagout: The placement of a tagout device on an energy isolating device, in accordance with an established procedure, to indicate that the energy isolating device and the equipment being controlled may not be operated until the tagout device is removed.

3.23 threshold limit values (TLV®s): Exposure limits published annually by the American Conference of Governmental Industrial Hygienists in *Threshold Limit Values and Biological Exposure Indices*. (TLV® is a registered trademark of the American Conference of Governmental Industrial Hygienists).

3.24 upper flammable limit (UFL): The maximum concentration of a vapor in air (or other oxidant) above which propagation of flame does not occur on contact with an ignition source. The upper flammable limit is usually expressed as