Browser does not support script. PWHT, or post-weld heat treatment, is its full name. Following a welding procedure, PWHT is a regulated process that involves warming the metal below its lower critical transition temperature. The material is then kept at a high temperature for a set amount of time to reduce residual stresses, boost strength, alter hardness, and lessen the possibility of cracking due to microstructural changes. Heat treatment applied after welding can be accomplished using various heating techniques. Steel assemblies undergo post-weld heat treatment (PWHT) to temper hard, potentially brittle microstructural areas and lower the degree of tensile welding residual stresses. This decreases the chance of brittle fracture. There is a financial incentive to avoid PWHT wherever possible because it can be a costly procedure, especially for large steel assemblies. The fracture toughness at the minimum service temperature, the stress levels, and the magnitude of any potential faults will determine whether PWHT is required. Some structures (such as those with modest thickness, according to current fabrication regulations) are exempt from PWHT. The exemptions vary amongst codes, though, therefore it would be preferable to bring some of these various criteria together. When is Post Weld Heat Treatment required? A method of changing the physical and occasionally chemical properties of metals, post-weld heat treatment is essentially the controlled heating and cooling of a metal or metal alloy while it is solid to achieve specific changes in its properties. The steel is often intended to be devoid of damaging, unevenly distributed internal stresses while still being strong and tough enough to be useful. In the welding zones, most traditional welding methods produce residual tensions. These stresses can become close to the material's yield strength when specific conditions are met. Such joints cannot be used directly and are prone to failure. Such welded steel assemblies receive PWHT to lessen the possibility of brittle fracture. The failure potential is decreased by PWHT's considerable reduction of the residual stresses in the weld joints. Therefore, PWHT is necessary whenever there is a chance of environmentally-assisted cracking. One or more of the following three basic factors may lead to heat treatment after welding: To ensure dimensional stability so that tolerances are maintained during machining processes or during shake-downs in service To create particular metallurgical structures to attain the necessary mechanical characteristics To decrease the residual stress in the welded component to lower the possibility of in-service issues such as stress corrosion or brittle fracture. Post-weld Heat Treatment for Carbon Steel PWHT is commonly applied to Carbon steels at a temperature of about 600°C for one hour per 25mm of thickness. Due to the lengthy hold durations, sluggish heating and cooling rates, and high cost of downtime, particularly when PWHT is performed after repairing an existing component, PWHT of big steel components is an expensive process. Therefore, it is highly requested that, whenever possible, PWHT be exempted. After each welding, Carbon Steel requires Post Weld Heat Treatment (PWHT) to maintain the part's material strength. The ASME BPVC code lists the precise requirements for PWHT of carbon steel. PWHT makes ensuring that residual stresses are minimized, material hardness is managed, and mechanical strength is improved. The standard for Post Weld Heat Treatment Current design rules for the piping and pressure vessel industries, such as the BSI and ASME codes, state that PWHT is necessary if the thickness of the components being welded exceeds a specific value; this limit is often determined by the material's Charpy test parameters and the minimum service temperature required. This strategy offers a quick and straightforward way to determine whether PWHT is necessary, and since the limiting thickness criterion has been in use for a long time, it can be regarded as having been validated by practice and tradition. However, it might be challenging to determine how conservative the codes are, and it is known that there are discrepancies in the limiting thickness values among different codes. There is a lot more room for using thick steel in the as-welded condition in the general structural industry for bridges, buildings, and offshore structures, but toughness requirements are getting tougher in terms of either higher Charpy energy absorption or lower temperatures for a reference level of energy absorption. Therefore, there is a lot of room to increase the PWHT exemption's geographic reach. Post Weld Heat Treatment According to ASME Section VIII The PWHT specifications for materials used in equipment manufactured in accordance with ASME are laid out in ASME Section VIII Div. 1. As described in ASME Section VIII Div.1, Tables UCS-56-1 through UCS-56-11 give the heating cycle data necessary for PWHT of materials based on P Number and Gr. Number as characterized in ASME Sec. IX. Following those tables are noted those list exceptions. Alternative heat treatment specifications for carbon and low alloy steels are provided in Table UCS-56.1. Before requesting the specific criteria and exemptions, it is necessary to successfully qualify the welding processes to be employed in line with all ASME Section IX requirements, including the requirements for post-weld heat treatment. When the nominal thickness, including the corrosion allowance, exceeds the limits stated in those tables, all welds in pressure vessels or pressure vessel parts must undergo a post-weld heat treatment at a temperature not less than indicated in those tables. Post-weld heat treatment is necessary for vessels or vessel parts made of P-No. 1 material that is impact tested at the MDMT when the minimum design metal temperature is colder than -55°F (-48°C) and the coincident ratio defined in Figure UCS-66.1 is 0.35 or higher. However, this requirement does not apply to the welded joints. When utilizing the electron beam welding process to weld ferritic materials thicker than 1/8 in. (3 mm), or when using the inertia and continuous drive friction welding processes to weld P-No. 3, P-No. 4, P-Nos. 5A, 5B, and 5C materials of any thickness, the exemptions listed in Tables UCS-56-1 through UCS-56-11 or Table UCS-56.1 are not permitted. Ferritic materials over 11/2 in. (38 mm) thick at the joint and electro slag welds must undergo a grain refining (austenitizing) heat treatment. The ferritic materials used in electro-gas welds must undergo a grain refining (austenitizing) heat treatment if the single pass is greater than 11/2 in. (38 mm). When pressure parts from two distinct P-Number groups are welded together, the material needing the higher post-weld temperature must be used for the post-weld heat treatment. The post-weld heat treatment temperature of the pressure component shall control when non-pressure parts are welded to pressure parts. Benefits of Post Weld Heat Treatment PWHT is a procedure that involves heating, soaking, and cooling the weldment or machined surface to controlled temperatures to minimize or redistribute the residual stress imposed by the welding process. The weldment's or surface's machining qualities are improved as a result. Additional advantages of PWHT include: the material's improved ductility, improved or decreased hardness lower likelihood of brittle fracture, unrestrained thermal stress as a result of blockage of residual stress, toughened metal, removal of hydrogen that is vaporized (to prevent hydrogen-induced cracking), and an enhanced metallurgical structure. Other advantages are steel assemblies that have been welded undergo post-weld heat treatment, principally to lessen the risk of brittle fracture. Tensile residual stresses in the weld joint are significantly reduced as a result of PWHT, and the heat-affected zone and weld metal microstructures are tempered to a smaller amount. Where there is a chance of environmental-assisted cracking, PWHT is necessary. It is essential to know that the residual stresses may mix with the service load stresses if PWHT is disregarded or carried out improperly. The value might be greater than the material's design constraints, which could cause weld failures, higher cracking potential, and increased susceptibility to brittle fracture. Requirements of Post Weld Heat Treatment A satisfactory weld procedure qualification of the welding procedures specification to be used must be performed per all the essential variables of ASME SECTION IX, including the conditions of post-weld heat treatment and other restrictions listed below, before applying for the detailed PWHT requirements and exemption in these paragraphs. The method of applying heat during local post-weld heat treatment must guarantee uniform temperature attainment at all points of the section being heat treated. Care must be taken to make sure that the heated band on either side of the weld edge is at least four (4) times the thickness of the pipe or two (2) inches, whichever is greater. The area outside the heated band must be appropriately wrapped in insulation throughout the post-weld heat treatment cycle to prevent any dangerous temperature disparity at the exposed surface of the pipe. The temperature of the pipe's exposed surface should not be permitted to get above 400°C for this purpose. The potential for damage during post-weld heat treatment requires the protection of valves, instruments, and other specific equipment with welding ends. Following PWHT, no welding is allowed. Employing automatically recording thermometers that have been properly calibrated is required. Before beginning the heat treatment procedures, the calibration chart for each recorder must be given to the owner for approval. Equipment used for recording must be calibrated at least once every 12 months. Additionally, the potentiometer that is used to calibrate recorders should be backed by a relevant certificate. When a manufacturer or a repair company performs heat treatment operations, other requirements, such as the differential in temperature across a specific length of the part, flame impingement, and finally, the rate of cooling acceptable to the code, are difficulties that must be taken into consideration. Method and Equipment of Post Weld Heat Treatment After all welding or repair work is finished, the welded joints on the pipes must undergo local post-weld heat treatment using the electric-resistance method. The resistance heater is made to fit each specific pipe and is electrically and thermally self-insulated. Depending on the required power, either 220 or 380 volts AC is provided across the coils. A temperature controller indicator and digital recorder are part of the post-weld heat treatment power control panel. A potentiometer that regulates the amount of power applied to the coils. An on/off switch, input and output connections for connecting the thermocouple to power, and indicator lights. Power contactors with the appropriate rating. One panel will be required for each heating operation since each panel will supply one heating station. By manually choosing the percentage of power input, heating and cooling rates are regulated using potentiometers. Temperature and Time Record in Post Weld Heat Treatment The actual temperature of the weld region will be displayed along with the post-weld heat treatment temperature, time, and heating and cooling rates that were automatically recorded. For each treated joint, a thermocouple must be linked to the recording and regulating device. The temperature of PWHT is not computed. The governing codes list the PWHT temperature range in tabular representations. Therefore, the PWHT temperature is chosen from the regulating code's tables. For process piping systems, see table 331.1.1 of ASME B31.3. Attachment of Thermocouple for Post Weld Heat Treatment A sufficient number of thermocouples (depending on the diameter of the pipes) shall be affixed to the pipe directly and evenly spaced locations throughout the periphery of the pipe junction after performing a visual inspection and removing surface flaws and temporary tack welds (if any). A minimum of one thermocouple must be attached to each joint for joints up to 3 inches in diameter, two up to 6 inches, three for joints up to 10 inches, and four for joints 12 inches and larger. The minimum number of thermocouples that must be installed can, however, be increased if deemed necessary. As close to the weld location as practicable, the thermocouples must be attached to the joint and in solid contact with the pipe. Thermocouples should be directly tack welded to the joint or heating band as long as their tails are made of the same material and the tack welding process uses an approved filler wire or electrode with a maximum diameter of 2.5 mm. The thermocouples must be shielded from direct radiation with ceramic fibre blanking or another appropriate insulating material to prevent inaccurate temperature readings as a result. Over the attached thermocouples throughout the heating band, heating resistance elements must be installed, and they must be insulated. Mineral or glass wool insulation must be able to withstand the temperature being used. Insulation must be at least 50 mm thick. Wire mesh must be wrapped around the insulation material and knotted, or secured in another appropriate way, to keep it in place. Heating, Cooling, and Handling regarding Post Weld Heat Treatment The difference between the temperatures detected by different thermocouples must be within the required range, and the heating temperature above 300°C must be recorded. The heating and cooling rate must not exceed that stated in associated WPS and standards but in no case more than 200°C/hr. According to the relevant welding technique parameters, the heat treatment socking temperature and holding period must be adhered to. The values for the various types of steel are provided in the following table for quick reference. Controlled cooling must be used to reduce the temperature to 300°c. Below that, a covering of insulation must be used for uncontrolled cooling to ambient temperature. Post Weld Heat Treatment in Reducing and Redistributing Residual Stress The material type, composition, PWHT temperature, and time spent soaking at that temperature all affect how much the residual stresses are relaxed. The joint should be immersed at peak temperature for 1 hour for every 25 mm (1 inch) of thickness, according to a generally used PWHT guideline, though in some circumstances, a minimum soak period will be stated. PWHT at higher temperatures allows for some tempering, precipitation, or ageing effects in addition to the reduction and redistribution of residual stresses during the welding process. These metallurgical modifications can make the structure less hard than it is after welding, improving ductility and lowering the likelihood of brittle fracture. However, in some steels, ageing/precipitation operations might lead to a decline in the steel's mechanical qualities; in this instance, professional guidance should be sought regarding the ideal periods and temperatures to utilize. PWHT is necessary depending on the service and material needs. The welding settings and the expected mode of failure are other factors that affect the necessity of PWHT. PWHT is required by some standards for specific grades or thicknesses, but when there is an alternative, the expense, and any drawbacks must be weighed against the potential benefits. Due to the high temperatures and lengthy times needed, energy costs are typically large, but delays in time may be more severe. The control of heating and cooling rates, holding temperature tolerances, and the times at temperature are extremely important and must be carefully controlled in order to realize the full benefit of the process. Negative effects include distortion, temper embrittlement, over-softening, and reheat cracking. Safety regarding Post Weld Heat Treatment The PWHT is required before hydrostatic testing and following any welded repairs. For post-weld heat treatment (PWHT), the manufacturer must outline the following: -How to load the furnace -Placing the thermocouples: how and where -System for recording time and temperature -Techniques for cooling and heating -Metal temperatures and their management -Supporting techniques for the vessel during PWHT The aforementioned safety measures are crucial to help ensure that the entire vessel receives an acceptable PWHT and to stop the vessel from deforming at temperatures above its design range. Other generic safety precautions that are significant to be taken into consideration are: Equipment and panels must be grounded properly. Electrical professionals must dress safely while working, including wearing rubber gloves, shoes, and other items. Only licensed electricians are permitted to work. To prevent unauthorized individuals from getting into contact with high-voltage electrical connections, joints under PWHT must be properly roped off with red tape, red lights, and danger signs. To prevent a person from falling, the proper platform needs to be created for in-place joints. Post Weld Heat Treatment in Piping The P-numbers and Group numbers of the pipe material determine the PWHT requirements for piping. The ASME B31.3 Clause 331.1.1, Tables 331.1.1 and 331.1.2 provide the PWHT requirements based on pipe materials. However, the required post-weld heat treatment can be skipped if the appropriate pre-heat temperature is used while welding pipes of the required thickness. The ASME B31.3 table 331.1.3 lists these regulations. Difference between Stress Relieving and Post Weld Heat Treatment Reducing residual stresses in an object is done through the stress-relieving method. To reduce the residual stresses created by welding, such techniques include normalizing, annealing, quenching, and tempering. PWHT is another procedure that helps people reduce stress. The primary distinction between PWHT and stress relief is that the former can be done at temperatures below the steel's minimum transformation temperature without causing the material to change microstructurally. Pipingmart is B2B portal specializes in industrial, metal and piping products. Also, share latest information and news related to products, materials and different types grades to help business dealing in this industry. ASME B31.3 covers the design, construction, inspection and maintenance of process piping systems used for transporting chemicals, oil or gas within industries. These piping systems may include boilers or heat exchangers. Post weld heat treatment (PWHT) reduces the likelihood of brittle fracture in welded steel components and is required as specified by Clause 331.1.1 and Table 331.1.1. Welding Procedures Procedures used to weld pipes are subject to various codes, which dictate their design according to specific requirements. Each procedure submitted for approval by a Procedure Engineer requires review in order to assess if they meet all necessary criteria; using their professional discretion they can determine whether a procedure will work effectively during real world welding assignments. Welding procedures serve as guides that direct welders throughout a job. These documents describe the weld process, required parameters and specific characteristics of a joint being welded – essential documents in guaranteeing high-quality welds produced from welding operations. Together with procedure specifications and welding qualification records (WPQRs), they form the cornerstone of quality welding joints. PWHT involves heating a pipe at an adjustable temperature for an arbitrary period. The exact time and temperature can depend on its material type and thickness. Before being cooled off, however, insulation must also be added to protect its welds against excessive heat loss during cooling down. A WPQR must include information for every weld: weld number, position, groove type and electrode type as well as complete material specification and grade details for every material type used during welds. In addition, preheating and interpass temperatures must also be specified according to relevant codes. Temperature Post Weld Heat Treatment (PWHT) is a controlled process in which materials welded during welding are heated below their lower critical transformation temperature and held there for a specified period. PWHT serves to remove residual stresses and microstructural changes; most codes, including ASME Section VIII Div. 1, require it; however there can be significant variances among different codes regarding its requirements. Differences in requirements largely arise from service conditions addressed by each code. Although minor variations may not cause too much concern, major disparities could potentially create serious safety concerns. For instance, an unreasonable PWHT requirement of 1100degF could lead to decreased hardness and toughness, while 1200degF would produce similar results. Piping systems are exposed to rigorous environmental and operational stresses. To ensure they remain safe and efficient, engineers and contractors must design them with appropriate material selection, welding techniques and inspection practices, in addition to conducting extensive exams of them. The ASME B31.3 standard provides an ideal framework for evaluating these stresses and meeting all necessary requirements – engineers and contractors alike can take advantage of understanding this standard to design safer systems with enhanced performance that also comply with all relevant safety standards. Time ASME B31.3 is an industry standard that sets forth guidelines for the design, construction, inspection, operation, testing and maintenance of piping systems. These regulations aim to make these systems safe for users as well as resilient against environmental and mechanical stresses. They provide detailed instructions on welding techniques used when building these systems as well as testing procedures to be taken when testing or maintaining. Adherence to ASME B31.3 requires a commitment to safety, thorough planning, and quality control at each stage of production, so as to prevent accidents while meeting desired quality and performance standards. This standard is particularly pertinent in industrial processes involving hazardous materials. ASME B31.3 can assist in meeting the requirements for installing either power or process piping systems, as well as outlining how to safely handle high-pressure systems which could prove hazardous if improperly handled. The 2014 edition of ASME b31.3 was revised to incorporate new PWHT requirements, clarified welding procedures, updated basic allowable stresses, and additional listed materials. Furthermore, welds on low-alloy steels must not contain more than 1.5% Cr and 0.5% Mo respectively and 2.0% Ni for stainless steel welds; this change was implemented to reduce risks of brittle fracture in these types of steels – an unprecedented development which will influence how we work on projects of this nature in future. Materials Post-weld heat treatment (PWHT) of carbon steel helps reduce residual stresses in weld areas and thus significantly decrease the risk of environmentally assisted cracking, making PWHT an essential step when welding carbon steel assemblies. PWHT requirements depend on code and material type; some welds may not require PWHT if their weld thickness falls within table 331.1.1's maximum threshold value. PWHT not only reduces the risk of environmental assisted cracking, but it also strengthens and toughens weld areas by increasing toughness and strength – an indispensable process for any pipe or pressure vessel that is exposed to harsh environmental conditions. Furthermore, its implementation is relatively simple and economical. EPRI report (Ref 1) recommended lowering PWHT temperatures, yet current B31.1 and B31.3 codes set a maximum PWHT temperature that is too high for this purpose. By decreasing it below the lower critical temperature for P No. 4 materials, additional margin could be created. PWHT requirements in piping and pressure vessels are determined by applicable codes and standards, which typically are derived from national or international central certification programs such as ASNT Central Certification Program (ACCP). To become certified under such programs, an NDT technician must undergo a comprehensive examination that may include radiographic/nonradiographic examinations, magnetic particle inspection, ultrasonic testing or any combination thereof. If you have purchased 3/4" nominal thickness pipe and it is slightly over .750" wall at any location , it is 3/4" nominal pipe size and is not subject to PWHT. The latest Editions of B31.1 and B31.3, exempt carbon steel pipe from PWHT, regardless of thickness, provided a 200F minimum preheat/interpass temp is maintained when T > 1" and multiple layer welds are used. Permissible variations in wall thickness acc. to SA-530 (general requirements) are 12.5% for under tolerance. Over tolerance depends on NPS (for 18" its 15%). Table 330.1.1 clearly calls for Nominal Wall Thickness. To my opinion, para. 331.1.3 only indicates the place to be referred in order to consider the thickness of the component that is to be welded. It not requires measuring the actual thickness at that place. PWHT needs are determined by the nominal thickness so the material should be PWHT. Weldstan - When referring to the latest code that is giving exception to the P1 over 3/4" rule. I only have access to a copy of 2013 are you refereeing to a addendum or the 2015 edition ? I have some 1.218 A333 24" welds that we would like to exempt if possible. I have reviewed my 2013 copy already and have not found anything. Thanks in advance for the help. B31.3 2014 Edition. Same is true for B31.1. The 2014 edt is not effective until 6 months after the date of issue, which I believe was 27 feb 2015. Please clarify my understanding, that per B31.3- 2014, PWHT is required for all thicknesses per table 331.1.1, while there is exemptions per Table 331.1.3 i.e. for P1 material having thickness greater than 1" PWHT is not required if preheated to 95 C (multiple layer welds t>5mm) and PWHT is required for all thickness lower than 1" for P1 materials. No. PWHT exemption applies to all thicknesses for P-No.1 base material. The additional limitation imposed by Table 331.1.3 is preheat is necessary for base material greater than 1". Dear metengr, it means PWHT is mandatory for thickness less than 1", however above 1" can be exempted due to preheat. What is the effective date of B31.3-2014 ? is there any code (ASME B31P) expected to cover the heat treatment requirement of B31.1 and B31.3? NowshadKhan, You are not grasping what is being said. PWHT is exempt for P1 materials of ALL THICKNESSES. If the nominal thickness is greater than 1" you must preheat to 200 Deg. F to avoid PWHT. David Thanks for the reply ..... if thickness is greater than 1" avoiding PWHT due to 95 C preheat is ok per table 331.1.3 as in my previous question but where is the reference that PWHT is exempt for P1 material for all thicknesses? Thanks for all the infos. I came across the latest edition few days back and also noticed the changes. Am I correct in interpreting : a. PWHT is exempted for P-1 materials for thickness up to 25mm? b. For Pipe to pipe branch connections with R'Pad, the computed thickness as per clause 331.1.3 (referring Fig 328.5.4D) shall be more than 25mm in order to carry out PWHT (as per table 331.1.3) A) Yes. However, if thickness is over 1" you don't have to PWHT. You must pre-heat to 200F prior to welding to be exempt from PWHT. B) Yes. But again, if computed thickness is over 1" you don't have to PWHT. Pre-heat to 200F prior to welding and no PWHT necessary. I am second guessing the response to B now. If computed thickness is >1" but nominals are