8.7.1.1.2 On-Line Maintenance.

8.7.1.1.2.1 Equipment shall be designed and procedures established to permit on-line maintenance of the control equipment.

8.7.1.1.2.2 Lockout or tag-out procedures shall be followed.

8.7.1.1.3 Procedures for calibrating and testing of controls and interlocks shall be provided.

8.7.1.2 Fuel Control.

8.7.1.2.1 Fuel input shall be controlled to maintain stable firing conditions.

8.7.1.2.2 Remote manual operation shall be permitted.

8.7.1.2.3 Minimum and maximum limits on the fuel input shall be established to prevent fuel flow beyond the stable limits of the fuel-burning system.

8.7.1.2.4* Automatic control of fuel input shall be permitted without automatic control of the air-fuel ratio.

8.7.1.3 Feedwater/Drum Level Control.

8.7.1.3.1 The water level in each drum shall be maintained automatically.

8.7.1.3.2 Remote manual operation of the feedwater control device shall be provided.

8.7.2 Monitoring.

8.7.2.1 Information about operating events shall be displayed to the operator.

8.7.2.2 Recording or trend displays of critical parameters listed in 8.7.2.3, taken at intervals no greater than 5 seconds, shall be provided to the operator at the operator location.

8.7.2.2.1 Where accessed through a video display unit (VDU) display in response to an alarm condition, the trend displays shall appear within 5 seconds.

8.7.2.2.2* Where VDU trend displays are used, the displays shall provide data that are current to within the prior 30 minutes at minimum, and the data provided shall have been stored when change exceeds 1 percent of calibrated instrument range.

8.7.2.3* The following HRSG parameters shall be continuously recorded on charts, or the data shall be logged and trended in accordance with 8.7.2.2.1 and 8.7.2.2.2:

(1) Water level in each steam drum
(2) Fuel pressure at the duct burner(s)
(3) Steam pressure at each pressure level
(4) Duct burner exit temperature before the first tube bank
(5) Atomizing media pressure (for liquid fuels only)
(6) Combustion turbine exhaust gas temperature upstream of the emissions control catalyst(s)
(7) HRSG flue gas exit temperature

8.7.3 Alarms.

8.7.3.1 Functional Requirements.

8.7.3.1.1 The alarm system shall alert the operator to specific upset conditions.

8.7.3.1.2 Alarms shall be provided to indicate equipment malfunction, hazardous conditions, or misoperation.

8.7.3.1.3 Defeating Alarms.

8.7.3.1.3.1 Alarms shall not be manually defeated.

8.7.3.1.3.2 Where equipment malfunction makes it necessary to defeat an alarm, it shall be performed by authorized personnel, and the alarm shall be tagged or logged as inoperative in accordance with plant operating procedures.

8.7.3.1.4 Audible and Visual Alarms.

8.7.3.1.4.1 Alarm systems shall be designed so that, for the alarms required by 8.7.3.2, the operator receives audible as well as visual signals.

8.7.3.1.4.2 The operator shall be permitted to silence the audible signal.

8.7.3.2 Required Alarms.

Δ **8.7.3.2.1 General Alarms.** The following alarms shall be required:

(1) Each trip, alarmed individually
(2) HRSG steam pressure (high) — high HRSG pressure at each steam pressure level
(3) Loss of interlock power
(4) Loss of control power
(5) Burner (if provided) safety shutoff valves not closed
(6) Steam drum(s) (if provided) water level (low)
(7) Loss of combustion turbine load
(8) Duct burner (if provided) outlet temperature (high)
(9) Flame detector (if provided) cooling air pressure (low)
(10) Loss of augmented air (if provided) supply
(11) Class 1 or Class 2 ignition fuel header (if provided) pressure (high and low)

Δ **8.7.3.2.1.1*** Loss of interlock power shall be sensed and alarmed and shall include all sources of power required to complete interlock functions.

Δ **8.7.3.2.1.2*** Loss of control power shall be sensed and alarmed to include any sources of power for the control systems.

8.7.3.2.1.3 The closed position of burner safety shutoff valves shall be monitored, and failure of any valve to close following a trip shall be alarmed.

8.7.3.2.2 Additional Alarms for Gaseous Fuels. The following additional alarms shall be required when gaseous fuels are being fired:

(1) Supply pressure (high and low)
(2) Burner header pressure (high and low)
(3) Flowmeter pressure (high and low)

8.7.3.2.2.1 The gas pressure supplied to the plant shall be monitored at a point upstream of the final constant fuel pressure regulator, main fuel control, and main safety shutoff valves.

8.7.3.2.2.2 The pressure at the gas flowmeter shall be monitored at the upstream tap if the gaseous fuel flowmeter is part of the HRSG control system and is not pressure compensated.

8.7.3.2.3 Additional Alarms for Liquid Fuels.

8.7.3.2.3.1 The following additional alarms shall be required when liquid fuels are being fired:

(1) Fuel supply pressure (low)

(2) Burner header pressure (low)
(3) Atomizing media pressure (low)
(4) Heated fuel temperature (low) or viscosity (high)

8.7.3.2.3.2 The fuel supply pressure shall be monitored at a point upstream of the fuel control and safety shutoff valves.

8.7.4 Interlocks.

8.7.4.1 Functional Requirements.

8.7.4.1.1 The HRSG interlocks shall be installed to protect personnel from injury and to protect equipment from damage.

Δ **8.7.4.1.2** The interlocks shall limit actions to a prescribed operating sequence or initiating trip(s).

8.7.4.1.3 Operating personnel shall be made aware of the limitations of the interlocks, given that it is possible to achieve conditions conducive to an explosion without their detection by any of the mandatory automatic trips and associated devices, even though such devices are adjusted and maintained.

•

8.7.4.1.4 The design of interlocks and associated devices shall include the following:

(1) Supervision of the starting procedure and operation
(2) Tripping of the minimum amount of equipment in the required sequence when the safety of personnel or equipment is jeopardized
(3) Indication of the initiating cause of the trip and prevention of the start of any portion of the process until operating conditions are established
(4) Coordination of the trips and associated devices into an integrated system
(5) Provisions of instrumentation to enable the operator or automatic equipment to complete the operating sequence
(6) Provision for preventive maintenance
(7) Interlocks that do not require defeating in order to start or operate equipment
(8) The independence of mandatory duct burner master fuel trip sensing elements and circuits from all other control elements and circuits except as permitted in 8.7.4.1.4.1 and 8.7.4.1.4.2
(9) Prevention of the misoperation of the interlocks and associated devices due to an interruption or restoration of the interlock energy supply

8.7.4.1.4.1 Individual burner flame detectors shall be permitted to be used for initiating duct burner master fuel trips.

8.7.4.1.4.2 Combustion turbine exhaust gas flow, combustion turbine load, airflow measurement, and auctioneered drum level signals from the HRSG control system shall be permitted to be used for a master fuel trip, provided all the following conditions are met:

(1) These interlocks are hardwired into the burner management system.
(2) Tripping set points are protected from unauthorized changes.
(3) Any single component failure of these sensing elements and circuits does not prevent a mandatory master fuel trip.

8.7.4.1.5 Interlocks including those functions outside the burner management system shall meet the functional requirements of 4.11.4.

8.7.4.2 Flame Detection.

8.7.4.2.1 Burner Supervision. Each burner element or zone shall be supervised individually, and on detection of loss of flame, the associated individual burner safety shutoff valve shall close automatically.

8.7.4.2.1.1 Redundant Flame Detectors.

(A) Where two flame detectors are fitted to each firing element, the flame detectors shall be arranged to alarm on loss of flame from one detector and to trip the system on loss of flame from two detectors.

(B) With one detector out of service, the remaining detector shall trip the system on loss of flame detection.

8.7.4.2.1.2 Flame Detection with Class 1 Igniters.

(A) Where Class 1 igniters are provided, the main burner flame shall be proven either by the flame detector or by proving the igniter.

(B) At least one flame detector shall be provided for each burner to detect the burner flame or igniter flame where a Class 1 igniter is provided.

8.7.4.2.1.3 Flame Detection with Class 2 Igniters. Burners with Class 2 igniters shall have at least two flame detectors.

(A) One detector shall detect the main burner flame and shall not detect the igniter flame.

(B) The second detector shall detect the igniter flame during prescribed light-off conditions.

8.7.4.2.1.4 Flame Detection with Class 3 Igniters. Burners with Class 3 igniters shall have at least one flame detector.

(A) The detector shall detect the igniter flame.

(B) The detector also shall detect the main burner flame after the igniter is removed from service at the end of the main burner trial for ignition.

8.7.4.2.1.5 Self-Checking Flame Detector. Where a self-checking flame detector is provided to each burner, a burner trip shall occur if the detector exhibits a self-check fault.

(A) Where two self-checking flame detectors are fitted to each burner, the flame detectors shall alarm on loss of flame or the self-check failure of one detector and shall trip the burner on loss of flame or the self-check failure of two detectors.

(B) With one detector out of service, the remaining detector shall trip the burner on loss of flame or self-check failure.

8.7.4.2.2 Where a hazardous condition results from loss of flame in more than one burner element or zone, a duct burner master fuel trip shall be initiated.

8.7.4.2.3 Regardless of the number or pattern of flame loss indications used for tripping, flame loss indication on a firing element shall initiate an alarm because any fuel input that does not ignite and burn creates a hazard.

8.7.4.2.4 Field testing shall be required to validate basic functions of flame tripping.

8.7.4.2.4.1 These tests shall be performed on representative units.

8.7.4.2.4.2 These tests shall not be used to replace an acceptance test related to proof of design, function, and components.

8.7.4.2.5 Field tests shall be performed to establish optimum sighting angles of firing elements or igniters and to check the angular range of the flame detector in relation to the firing elements or igniters.

8.7.4.3 Duct Burner Master Fuel Trip. For an operating duct burner, including the start-up or shutdown sequences, a duct burner master fuel trip shall be initiated by the following conditions:

(1) Low fuel pressure
(2) Combustion turbine exhaust or fresh air (if provided) flow across the duct burner that drops below the minimum required for operation of the duct burner as specified by the burner manufacturer or as proven by trial; it is permitted to infer this flow from the operating status of the combustion turbine, fresh air fan (if provided), and damper(s) (if provided) position(s)
(3) Combustion turbine trip except for systems operating as defined in 8.10.2.4
(4) Loss of all burner flame other than during a normal duct burner shutdown sequence
(5) Partial loss of flame determined to create a hazardous accumulation of unburned fuel at any burner element or zone
(6) Loss of duct burner element(s) resulting in incorrect element firing configuration, in accordance with 8.8.5.8.3.2
(7) Light-off failure of first burner in multiple burner operation
(8) Failure to prove a safety shutoff valve closed on command to close
(9) Closing of last individual burner safety shutoff valve other than during a normal duct burner shutdown sequence
(10) High fuel pressure
(11) Low water level on high pressure section of HRSG
(12) Loss of energy supply for HRSG control system, burner management system, or interlocks
(13) Low atomizing media (if provided) supply pressure
(14) Detection of burner management system malfunction
(15) Manual trip *[See 4.11.7(8).]*
(16) Loss of augmented air supply where the operation of the duct burner requires augmented air
(17) Fresh air (if provided) transfer failure *(See 8.10.2.4.)*
(18) Logic controller failure *[See 4.11.7(10) and 4.11.7(11).]*

8.8 Purge, Start-up, Operation, and Shutdown of HRSG and Other Combustion Turbine Exhaust Systems.

8.8.1* General.

8.8.1.1 The requirements of Section 8.8 shall apply where gaseous or liquid fuels are being burned in HRSG or other combustion turbine exhaust systems, and these requirements shall include interlocks for ensuring prescribed action, burner management system trips, flame detection, and an indication of the status of the operating sequences.

8.8.1.2 In addition, the requirements of Section 8.8 shall apply to the design, installation, and operation of duct burners in HRSG systems. No specific degree of automation beyond the minimum specified safeguards is defined or shall be required, because this is subject to factors such as, but not limited to, physical size of the unit, use of the central control room, degree of reliability required, and experience level of operating personnel.

8.8.1.2.1 A trained operator with access to control equipment shall be stationed to perform the required actions to ensure operation in accordance with the manufacturer's recommendations.

8.8.1.2.2 The start-up of the burner as a first-time function shall be accomplished by an operator at the burner location who has a direct view of the burner.

8.8.1.2.3 Recycling of the burner in response to steam demand shall be permitted to be an automatic sequence, provided the combustion turbine has not tripped.

8.8.1.2.4 Equipment shall be provided to control HRSG inputs to maintain stable flame throughout the full operating range in accordance with the manufacturer's recommendations.

8.8.2 General Operating Requirements.

8.8.2.1 Prior to Starting. Prior to the starting of a unit, action shall be taken to prevent fuel from entering the HRSG or other combustion turbine exhaust systems.

8.8.2.2 Ignition.

8.8.2.2.1 The associated igniter for a duct burner shall always be used unless the burner is specifically designed to be lit from an adjacent burner.

8.8.2.2.2 Burners shall not be lit from any hot surface.

8.8.2.3 Low Capacity Fuel Pressure. Where operating at low capacity, duct burner fuel pressure shall be maintained above the minimum pressure for stable flame by reducing the number of burners in service as necessary.

8.8.2.4 Gaseous Fuel. Before maintenance is performed on the fuel header, it shall be purged. *(See Annex I.)*

8.8.2.5 Liquid Fuel. Before maintenance is performed on the fuel header, it shall be drained and purged. *(See Annex I.)*

8.8.2.6 Liquid Fuel — Scavenging of Liquid Fuel Burner Passages.

8.8.2.6.1 Burner passages shall not be scavenged into a nonoperating HRSG.

8.8.2.6.2 Combustion turbine exhaust flow shall be functioning and shall be maintained during the scavenging process.

8.8.2.6.3 Igniters, with ignition established, shall be in service when scavenging fuel passages into the HRSG.

8.8.2.7 Sequencing.

8.8.2.7.1 Sequencing shall be required to ensure that operating events occur in the prescribed order.

8.8.2.7.1.1 Written procedures shall be provided to sequence the start-up and shutdown of the HRSG system in accordance with this code and with the manufacturer's recommendations.

8.8.2.7.1.2 Sequencing also shall be utilized when burners are being removed from operation or when burners are being added to operation.

8.8.2.7.2* The start-up and shutdown sequences outlined in Section 8.8 shall be followed.

8.8.2.7.3* Placing Duct Burners into Service.

8.8.2.7.3.1 Duct burners shall be placed in service and removed from service in a sequence specified by operating instructions and verified by actual experience with the unit.

8.8.2.7.3.2 Duct burners shall be placed in service with fuel flow as recommended by the manufacturer.

8.8.2.7.4 If the fuel pressure at the burner header is used as a guide in maintaining the necessary fuel flow per burner, it shall be maintained automatically within prescribed limits as additional burners are placed in service.

8.8.2.7.5 Duct burners shall be operated in accordance with the manufacturer's specifications and operating procedures.

8.8.2.7.6 This procedure shall incorporate the following operating objectives:

(1) Purge shall be completed in accordance with 8.8.4 and 8.8.5.
(2) No light-off of the duct burner(s) shall occur until after the combustion turbine has established stable operation with an exhaust gas flow not less than that necessary for duct burner operation.

8.8.2.7.7 Each unit shall be tested during commissioning to determine whether any modifications to the basic procedures are needed to obtain reliable ignition and system operation.

8.8.2.7.8 The unit shall be operated within the specified parameters, and any modifications or deviations shall be made only after the need for such changes has been determined by operating experience and system review.

8.8.3 Cold Start Preparation. Preparation for starting shall require an inspection that includes the following:

(1) A unit free of foreign material and not in need of repair
(2) A unit inspected for accumulated liquid fuel, and draining and cleaning performed if such accumulation is present
(3) All personnel evacuated from the unit and associated equipment and all access and inspection doors closed
(4) All combustion turbine fuel safety shutoff valves and duct burner and igniter safety shutoff valves proved closed by valve position and all ignition sources de-energized

Exception: Where the igniter capacity is 1.5 MW_t (5 million Btu/hr) or less, proof of closure of igniter safety shutoff valves by means other than valve position shall be permitted.

(5) Gaseous fuel system vents open and venting to an outside location that does not present a hazard; fuel lines drained of condensate
(6) Circulating valves open to provide and maintain liquid fuel flow in the burner headers
(7) Prescribed drum water levels established in natural and forced circulation HRSGs and prescribed flow established in forced circulation and once-through HRSGs
(8) Burner elements and igniters positioned in accordance with manufacturer's specification
(9) Energy supplied to control systems and to interlocks
(10) Meters or gauges indicating fuel header pressure to the unit
(11) Instrumentation tested and functional
(12) A complete functional check of the interlocks performed after an overhaul or other interlock-related maintenance
(13) Verification of an open flow path through the HRSG system

8.8.4 Combustion Turbine Purge and Light-Off.

Δ **8.8.4.1* Combustion Turbine Purge Process.** The purge of the combustion turbine shall be in accordance with the manufacturer's instructions and with the requirements of 8.8.4.2.

N **8.8.4.1.1** A combustion turbine purge in accordance with 8.8.4.2 .shall not be required on subsequent starts if purge credit is maintained in accordance with 8.8.4.6 or 8.8.4.7.

8.8.4.1.2 Where a combustion turbine or HRSG is provided with fuel systems for multiple fuels, the purge requirements for each type of fuel shall be met.

8.8.4.2 Initial Combustion Turbine Purge and Light-Off.

N **8.8.4.2.1** Purge of the HRSG or other combustion turbine exhaust systems prior to the light-off of the combustion turbine shall be accomplished by at least five volume changes at purge rate and for a duration of not less than 5 minutes.

8.8.4.2.2 Purge of exhaust bypass systems shall be accomplished as follows:

(1) Where the bypass system includes an exhaust system [such as a selective catalytic reduction (SCR) system], the purge shall be accomplished by at least five volume changes at purge rate and for a duration of not less than 5 minutes.
(2)* Where the bypass system consists of only ductwork and a damper, the bypass system purge shall be accomplished by at least five volume changes at purge rate.

N **8.8.4.2.3 Purge Volume.**

8.8.4.2.3.1 This volume shall be calculated based on the following:

(1) The volume from the combustion turbine inlet to the portion of the HRSG or other combustion turbine exhaust systems where the combustion turbine exhaust gas temperature is reduced to at least 56°C (100°F) below the lowest autoignition temperature of the fuel(s) for which the system has been designed
(2) The temperature profile in the HRSG in 8.8.4.2.3.1(1) is based on the combustion turbine operating at full load with no supplementary HRSG firing.

8.8.4.2.3.2 In no case shall the volume in 8.8.4.2.3.1(2) be less than the volume of the HRSG enclosure between the combustion turbine outlet and the outlet of the first evaporator section in the HRSG. For other combustion turbine exhaust systems without heat recovery, the purge volume shall extend to the stack inlet.

8.8.4.2.4 Purge Rate.

8.8.4.2.4.1 The purge rate shall provide the required velocity in the HRSG enclosure or other combustion turbine exhaust systems to ensure dilution and removal of combustible gases prior to turbine light-off.

8.8.4.2.4.2 The adequacy of this purge rate shall be demonstrated by one of the following methods:

(1) During the purge of the combustion turbine, a flow rate of not less than 8 percent of full-load mass airflow is provided through the HRSG or other combustion turbine exhaust systems, regardless of damper leakage or degradation in the HRSG enclosure or exhaust system.
(2)* An engineering model of the system from the outlet of the turbine to the outlet of the HRSG or other combustion turbine exhaust systems has been created, and purge adequacy has been demonstrated with flow testing performed at the equivalent purge conditions.
(3) A HRSG or other combustion turbine exhaust system burning fuel(s) of equal density and with the same ductwork and stack geometry has been installed and has a documented history of successful start-ups performed in accordance with the manufacturer's recommendations and without occurrences of uncontrolled combustion of fuel accumulations in the HRSG or other combustion turbine exhaust system during turbine light-off.
(4) Provision of combustible gas analyzers that would prevent start-up of the combustion turbine if combustible gas concentrations greater than 25 percent of the lower explosive limit (LEL) exist in the HRSG or other combustion turbine exhaust systems.

8.8.4.2.5 In the event that the combustion turbine cannot meet the requirements of 8.8.4.2.4, alternative or supplementary means to satisfy the flow requirements through the HRSG enclosure or other combustion turbine exhaust systems shall be provided.

8.8.4.2.6* Where augmented air firing or tempering air is provided, the augmented or tempering air system shall be purged during the combustion turbine purge in accordance with the combustion turbine and HRSG manufacturers' operating instructions.

8.8.4.3 Failure to Start. On failure to start, retrial of the combustion turbine start shall be permitted following a repurge in accordance with 8.8.4.2.

8.8.4.3.1 When operating experience indicates there are problems in combustion turbine light-off, the light-off attempts shall be terminated and the cause investigated and corrected.

8.8.4.3.2 When any liquid fuel or gaseous fuel that is heavier than air is being fired, verification shall be made that the low point drains are clear of fuel.

8.8.4.3.3 The second trial to start the combustion turbine with the same or alternative fuel shall be permitted following a repurge in accordance with 8.8.4.2.

8.8.4.3.4 Subsequent trials to start the combustion turbine with the same or alternative fuel shall be permitted following a repurge in accordance with 8.8.4.2 and after proving that combustibles have been removed.

8.8.4.3.5 In the analysis for combustibles, the sampling point(s) shall be selected on the basis of the following:

(1) Fuel(s)
(2) HRSG or other combustion turbine exhaust system configuration
(3) Stratification of gases

8.8.4.4 Light-Off Airflow. After the purge has been completed, the airflow through the combustion turbine shall be permitted to be dropped below the purge rate if required by the design to accomplish combustion turbine ignition.

8.8.4.5 Loading of Combustion Turbine.

8.8.4.5.1 After successful light-off of the combustion turbine, the combustion turbine shall be brought to speed and loaded as necessary to meet system demands.

8.8.4.5.2 The loading of the combustion turbine shall be performed in accordance with the manufacturer's requirements and with any restrictions imposed by HRSG parameters.

8.8.4.6* Combustion Turbine Purge Credit for Gaseous Fuel Systems. Following a combustion turbine normal shutdown, combustion turbine purge credit shall be permitted to be established for the next start-up event provided that the following requirements are met for each combustion turbine and duct burner fuel system.

8.8.4.6.1* Combustion turbine and duct burner manufacturer's valve-proving requirements, fuel supply system requirements, and safety control system requirements shall be met.

8.8.4.6.2 A positive means to prevent leakage of ammonia into the idle HRSG or other combustion turbine exhaust system shall be provided in accordance with 4.10.3.

8.8.4.6.3 A triple block and double vent valve arrangement is installed on the combustion turbine in accordance with 8.4.2.1.2.2 and is installed on the HRSG fuel burning system (if provided) in accordance with 8.4.3.2.2.2.

8.8.4.6.4 One of the following shall be used to establish the purge credit.

(A)* Valve Proving Method.

(1) Where provided, duct burner normal shutdown shall be accomplished.
(2)* Combustion turbine normal shutdown shall be accomplished.
(3) The vent valves shall remain in the fully open position as long as purge credit is established.
(4) Fuel gas block and vent valve positions shall be continuously monitored. If continuous monitoring is lost or any valve deviates from its assigned position, purge credit is lost, and subsequent start of the combustion turbine requires a combustion turbine purge prior to light-off, in accordance with 8.8.4.2.
(5) Pressures in the two double block and vent pipe sections shall be continuously monitored. If continuous monitoring is lost or either pressure indicates leakage, purge credit is lost, and subsequent start of the combustion turbine requires a combustion turbine purge prior to light-off, in accordance with 8.8.4.2.
(6) Prior to each start-up and following each normal shutdown, block valves shall be validated for gas leak tightness via a valve-proving system. As a minimum, the most downstream block valve shall be valve proved during the start-up sequence, and the middle block valve shall be valve proved during the shutdown sequence. The most downstream block valve shall be tested only when airflow is passing through the combustion turbine.
(7) The combustion turbine purge credit period shall not exceed 8 days (192 hours). If a combustion turbine purge in accordance with 8.8.4.2 is performed during the 8-day

period, the combustion turbine purge credit is reinitiated for an 8-day period.

(B)* Pressurized Pipe Section Method.

(1) Where provided, duct burner normal shutdown shall be accomplished.
(2)* Combustion turbine normal shutdown shall be accomplished.
(3) The upstream vent valve shall remain in the fully open position, and the downstream vent valve shall remain in the fully closed position as long as purge credit is established.
(4) Air or inert gas shall be introduced to create and maintain a pressurized pipe section between the middle and most downstream block valves.
(5) Fuel gas block and vent valve positions shall be continuously monitored. If continuous monitoring is lost or any valve deviates from its assigned position, purge credit is lost and subsequent start-up of the combustion turbine requires a combustion turbine purge prior to light-off, in accordance with 8.8.4.2.
(6) Pressures in the two double block and vent pipe sections shall be continuously monitored. If continuous monitoring is lost or the pressure downstream of the middle block valve decreases to less than 20.7 kPa (3 psid) above the upstream pressure, purge credit is lost and subsequent start-up of the combustion turbine requires a combustion turbine purge prior to light-off, in accordance with 8.8.4.2.
(7) The combustion turbine purge credit period shall be considered to be maintained as long as the conditions in 8.8.4.6.4(B)(4), 8.8.4.6.4(B)(5), and 8.8.4.6.4(B)(6) are met.
(8) Provisions shall be made to ensure that fuel cannot enter the air or inert gas supply line at any time.

8.8.4.7 Combustion Turbine Purge Credit for Liquid Fuel Systems. Following a normal shutdown, combustion turbine purge credit shall be permitted to be established for the next start-up event provided that the following requirements are met for each combustion turbine and duct burner fuel system.

8.8.4.7.1* Combustion turbine and duct burner manufacturer's fuel supply valve monitoring system requirements and safety control system requirements shall be met.

8.8.4.7.2 A positive means to prevent leakage of ammonia into the idle HRSG or other combustion turbine exhaust system shall be provided in accordance with 4.10.3.

8.8.4.7.3 A triple block and double drain valve arrangement is installed on the combustion turbine in accordance with 8.4.2.1.1.2 and is installed on the HRSG fuel burning system (if provided) in accordance with 8.4.3.2.2.3.

8.8.4.7.4 One of the following shall be used to establish the purge credit.

(A) Proof-of-Closure Method.

(1) Where provided, duct burner normal shutdown shall be accomplished.
(2)* Combustion turbine normal shutdown shall be accomplished.
(3) The drain valves shall remain in the fully open position as long as purge credit is established.
(4) Liquid fuel block and drain valve positions shall be continuously monitored. If continuous monitoring is lost or any valve deviates from its assigned position, purge credit is lost, and subsequent start of the combustion turbine requires a combustion turbine purge prior to light-off, in accordance with 8.8.4.2.
(5) Pressures in the two double block and drain pipe sections shall be continuously monitored. If continuous monitoring is lost or either pressure indicates leakage, purge credit is lost, and subsequent start of the combustion turbine requires a combustion turbine purge prior to light-off, in accordance with 8.8.4.2.
(6) The combustion turbine purge credit period shall not exceed 8 days (192 hours). If a combustion turbine purge in accordance with 8.8.4.2 is performed during the 8 day period, the combustion turbine purge credit is reinitiated for an 8 day period.

(B)* Pressurized Pipe Section Method.

(1) Where provided, duct burner normal shutdown shall be accomplished.
(2)* Combustion turbine normal shutdown shall be accomplished.
(3) Air or inert gas shall be introduced to create and maintain a pressurized pipe section between the middle and most downstream block valves.
(4) An inert liquid shall be permitted to be used in lieu of inert gas if acceptable to the original equipment manufacturer.
(5) The upstream drain valve shall remain in the fully open position, and the downstream drain valve shall remain in the fully closed position as long as purge credit is established.
(6) The liquid fuel block and drain valve positions shall be continuously monitored. If continuous monitoring is lost or any valve deviates from its assigned position, purge credit is lost and subsequent start of the combustion turbine requires a combustion turbine purge prior to light-off, in accordance with 8.8.4.2.
(7) Pressures in the two double block and drain pipe sections shall be continuously monitored. If the continuous monitoring is lost or the pressure downstream of the middle block valve decreases to less than 20.7 kPa (3 psid) above the upstream pressure, purge credit is lost and subsequent start-up of the combustion turbine requires a combustion turbine purge prior to light-off, in accordance with 8.8.4.2.
(8) The combustion turbine purge credit period is maintained as long as the conditions in 8.8.4.7.4(B)(5), 8.8.4.7.4(B)(6), and 8.8.4.7.4(B)(7) are met.
(9) Provisions shall be made to ensure that fuel cannot enter the air, inert gas, or inert liquid supply line at any time.

(C)* Liquid Level Monitoring Method.

(1) In addition to the triple block and double drain valve arrangement, a vertical pipe section shall be installed between the two most downstream block valves that includes a vertical rise above the liquid supply level with a vent valve installed at the top of the riser.
(2) Where provided, duct burner normal shutdown shall be accomplished.
(3)* Combustion turbine normal shutdown shall be accomplished.
(4) The vent valve and drain valves shall remain in the fully open position as long as purge credit is established.
(5) The block valves, drain valves, and the vent valve positions shall be continuously monitored. If continuous monitor-

ing is lost or any valve deviates from its assigned position, purge credit is lost and subsequent start of the combustion turbine requires a combustion turbine purge prior to light-off, in accordance with 8.8.4.2.

(6)* The vertical riser between the two most downstream block valves shall be continuously monitored for the absence of liquid. If the continuous monitoring is lost or the liquid fuel level rises above the limit level, purge credit is lost and subsequent start-up of the combustion turbine requires a combustion turbine purge prior to light-off, in accordance with 8.8.4.2.

(7) The combustion turbine purge credit period is maintained as long as the conditions in 8.8.4.7.4(B)(5) and 8.8.4.7.4(B)(6) are met.

8.8.5 Duct Burner Purge and Light-Off.

8.8.5.1 The duct burner purge shall be accomplished with a flow utilizing air or combustion turbine exhaust at not less than 25 percent of full-load mass flow rate or the minimum flow necessary for operation of the duct burners, whichever is greater.

8.8.5.2 The duct burner purge shall accomplish at least eight volume changes of the HRSG enclosure, after combustion turbine exhaust flow rate has been achieved in accordance with 8.8.5.1.

8.8.5.3 Purge prior to light-off of the combustion turbine shall not be considered a duct burner purge unless the requirements of 8.8.5.1 and 8.8.5.2 have been satisfied.

8.8.5.4 Augmented Air System Purge.

8.8.5.4.1 Where augmented air firing is provided, the augmented air plenum and associated ductwork shall be purged into the HRSG enclosure.

8.8.5.4.2 This purge shall be performed in addition to the duct burner purge required in 8.8.5.2.

8.8.5.5 A duct burner trip or failure to light off duct burners successfully shall require a repurge in accordance with 8.8.5.1 and 8.8.5.2 prior to attempting a relight.

8.8.5.6 Duct Burner Purge Credit.

8.8.5.6.1 A duct burner purge shall be considered to have been achieved, provided the duct burner purge rate is maintained and all duct burner purge requirements have been satisfied.

8.8.5.6.2 The duct burner shall be permitted to be lit or a normal shutdown made provided that credit for the purge is maintained.

8.8.5.6.3 Failure of the duct burner purge rate to be maintained or failure to meet any duct burner purge requirement shall require a repurge in accordance with 8.8.5.1 and 8.8.5.2.

8.8.5.6.4 The mass flow of combustion air to the duct burner system shall be maintained at or above its purge rate and within the duct burner design operating range during all operations of the duct burner system.

8.8.5.7 Testing igniters for duct burners shall be conducted in accordance with the following:

(1) Operational tests of each igniter shall be made.

(2) The frequency of testing shall be based on the design and operation history of each individual HRSG and ignition system.

(3) The test shall be made during each start-up following an overhaul or other igniter-related maintenance.

(4) Individual igniters or groups of igniters shall be permitted to be tested while the unit is in service. Such tests shall be made with no main fuel present in the igniter's associated burner.

8.8.5.8* Starting Sequence. The operating sequences described in 8.8.5.8 shall be used for multiple element duct burners operated independently of each other.

8.8.5.8.1 For installations with a duct burner (single element or multiple element) operated as a single unit, the applicable procedures outlined in 8.8.5.8.3 shall be followed.

8.8.5.8.2 The starting sequence shall be as required in 8.8.5.8.2.1 through 8.8.5.8.2.10.

8.8.5.8.2.1 All duct burner and igniter safety shutoff valves shall be proven to be closed in accordance with 8.8.3(4).

8.8.5.8.2.2 The main fuel header and the igniter fuel header shall be pressurized up to the individual burner and igniter safety shutoff valves in accordance with established operating procedures.

8.8.5.8.2.3 The individual igniter safety shutoff valve(s) shall be opened, and the ignition transformer(s) shall be energized with the following conditions observed:

(1) If an igniter's flame is not proven within 10 seconds after its igniter safety shutoff valve has been opened, its safety shutoff valve shall be closed.

(2) The cause of failure to ignite shall be determined and corrected.

(3) With turbine exhaust flow maintained, repurge shall not be required, but at least 1 minute shall elapse before a retrial of any igniter(s) is attempted.

8.8.5.8.2.4 The main fuel control valve shall be set to and proven to be at the burner light-off position.

8.8.5.8.2.5 Where igniter flames are proven, the individual burner safety shutoff valve(s) shall be opened under the following conditions:

(1) If no burner flame is proven within 5 seconds after main fuel enters the duct, a duct burner master fuel trip shall occur.

(2) Where flame is not proven on an individual burner, that individual burner's safety shutoff valve and individual igniter safety shutoff valve shall close.

(3) The cause for failure to ignite shall be determined and corrected.

(4) At least 1 minute shall elapse before the next light-off is attempted.

8.8.5.8.2.6 After each stable burner flame is proven, the igniter shall be shut off unless classified as Class 1 or Class 2, and the stability of the burner flame shall be verified.

8.8.5.8.2.7 The associated igniter for a burner shall be used to light the burner unless the burner is specifically designed to be lit from an adjacent burner; burners shall not be lit from any hot surface.

8.8.5.8.2.8 Second or succeeding igniters shall be lit in accordance with 8.8.5.8.2.3.

8.8.5.8.2.9 Second or succeeding burners shall be lit in accordance with 8.8.5.8.2.5. The main fuel control valve shall not be modulated when second or succeeding burners are being brought into service.

8.8.5.8.2.10 After each successive burner light-off, the operator shall verify the flame stability of all operating burners.

8.8.5.8.3 Single Burner Operations.

8.8.5.8.3.1 Single burner operation shall be allowed when the burner elements have individual safety shutoff valves.

8.8.5.8.3.2 An operating procedure shall be developed to prescribe the number(s) and location(s) of burner elements allowed to be out of service as defined by the HRSG and duct burner manufacturers.

8.8.6 Normal Operation.

8.8.6.1 The combustion turbine load, exhaust flow and temperature, and duct burner firing rate shall remain within the acceptable range as determined by the HRSG manufacturer during all operating modes.

8.8.6.2 The HRSG steaming rate shall be regulated by combustion turbine loading and duct burner exhaust temperature.

8.8.6.3 The firing rate shall be regulated by varying the fuel to individual burners by means of a fuel control valve(s) or by staged firing where burners are brought in or taken out of service.

8.8.6.3.1 Individual burner safety shutoff valves shall not be used to vary the fuel rate of the burner elements.

8.8.6.3.2 All safety shutoff valves shall be fully open or completely closed.

8.8.6.4 The burner fuel shall be maintained within a range between the maximum and minimum limits specified by the burner and HRSG manufacturers or as determined by trial.

8.8.6.4.1 These trials shall test for minimum load and for stable flame as follows:

(1) With all burners in service and combustion control on automatic
(2) With different combinations of burners in service and combustion control on automatic

8.8.6.4.2 When changes occur to the minimum and maximum limits because of various burner combinations and fuel conditions, retesting shall be required.

8.8.6.5 On loss of an individual burner flame, that burner's individual safety shutoff valve and the associated igniter safety shutoff valve shall close.

8.8.7 Normal Shutdown.

8.8.7.1 Burners shall be shut down sequentially by closing the individual burner safety shutoff valves or in unison by closing all safety shutoff valves.

8.8.7.2 The duct burners shall be taken out of service with verification that the safety shutoff valves are secured in the closed position.

8.8.7.3 The automated vent or drain valve associated with the main safety shutoff valves shall be opened.

8.8.7.4* The duct burners shall be taken out of service in a manner that relieves fuel pressure in the pipe section between the two most downstream safety shutoff valves.

8.8.7.5 When the unit (combustion turbine and duct burner) is being taken out of service, the combustion turbine load shall be reduced in accordance with the manufacturer's shutdown procedures.

8.8.7.5.1 Required steam flow shall be maintained through the superheater.

8.8.7.5.2 Leakage of fuel into the unit shall be prevented.

8.8.7.6 When establishing a combustion turbine purge credit in accordance with 8.8.4.6.4(B), the following procedure shall be implemented prior to combustion turbine shutdown for duct burners utilizing gaseous fuels (Pressurized Pipe Section Method):

(1) Open both vent valves of the duct burner fuel supply.
(2) Admit the blocking medium to purge any remaining fuel until the fuel level is less than 25 percent of the LEL.
(3) Close the downstream (header) vent valve.
(4) Establish and maintain the required blocking pressure

8.8.7.7 When establishing a combustion turbine purge credit in accordance with 8.8.4.7, the following procedure shall be implemented prior to combustion turbine shutdown for duct burners utilizing liquid fuels after scavenging in accordance with 8.8.2.6:

(1) Open both drain valves of the duct burner fuel supply.
(2) Admit the blocking medium to purge any remaining fuel.
(3) Close the downstream (header) drain valve.
(4) Establish and maintain the required blocking pressure.

8.8.8 Normal Hot Restart.

8.8.8.1 When a hot combustion turbine is restarted, the requirements for cold start preparation as described in 8.8.3(4) through 8.8.3(10) and 8.8.3(13) shall be followed.

8.8.8.2 The starting sequences of 8.8.4 and 8.8.5 shall be followed.

8.8.9 Duct Burner Master Fuel Trip.

8.8.9.1 A duct burner master fuel trip shall be initiated by the conditions identified in 8.7.4.3.

8.8.9.2 Gaseous Fuel.

8.8.9.2.1 A duct burner master fuel trip shall stop all fuel flow to the HRSG from all burners by tripping the main and individual burner safety shutoff valves.

8.8.9.2.2 The automated vent valve associated with the main safety shutoff valves shall be opened.

8.8.9.2.3 The igniter safety shutoff valves and individual igniter safety shutoff valves shall be tripped and igniter sparks de-energized.

8.8.9.2.4 Duct burner master fuel trips shall operate to stop all fuel flow to the burners.

8.8.9.3 Liquid Fuel.

8.8.9.3.1 A duct burner master fuel trip shall stop all fuel flow to the HRSG from all burners by tripping the main and individual burner safety shutoff valves.

8.8.9.3.2 The igniter safety shutoff valves and individual igniter safety shutoff valves shall be tripped and igniter sparks de-energized.

8.8.9.3.3 Duct burner master fuel trips shall operate to stop all fuel flow to the burners.

8.8.9.4 The burners shall not be reignited until the initiating trip condition has been investigated and corrected and a duct burner purge has been completed.

8.9 Combustion Turbine Exhaust Bypass Systems.

8.9.1* General.

8.9.1.1 The requirements of Section 8.9 shall apply to HRSG systems equipped with HRSG isolation and bypass dampers or a diverter damper.

8.9.1.2 Because the application of dampers in HRSG systems adds to the complexity of the systems and presents hazards that cause additional safety and property damage exposures, the owner or owner's representative shall evaluate the hazards of the proposed configuration.

8.9.1.3 The owner or owner's representative shall apply safeguards to reduce the exposures identified in 8.9.1.2.

8.9.1.4 The hazard evaluation and proposed measures to reduce the hazards shall be documented and kept on file for review.

8.9.1.5 Requirements of Chapter 1 and Chapter 4 and preceding sections of Chapter 8 shall be applied, unless amended by Section 8.9 or by the hazard evaluation.

8.9.1.6 The owner or owner's representatives shall address the implications of the following hazards associated with damper applications:

(1) Due to the physical size, shape, and mass, a damper cannot be assumed to fully seal a combustion turbine exhaust gas flow path.
(2) A leaking fuel valve or a combustion turbine false start will result in an explosive mixture in the HRSG on either or both sides of a damper during shutdown periods.
(3) Failure to purge an explosive mixture prior to introduction of hot turbine exhaust gas will result in ignition of the mixture. Even at full speed and no load, the combustion turbine exhaust temperatures can be above the autoignition temperatures for combustion turbine and HRSG fuels.
(4) Systems using two stacks (HRSG and bypass), with or without dampers, tend to induce a reverse flow of fresh air through the HRSG as a result of the high temperature combustion turbine exhaust gas flow up the bypass stack.
(5) Failure of damper-operating mechanisms will allow instantaneous reversal of damper position (from open position to closed position and vice versa) due to aerodynamic effects with the following results:
    (a) Sudden closure of an operating combustion turbine free exhaust path will result in high transient duct internal pressures.
    (b) These high pressures can cause distortion of the HRSG enclosure and rupture of the duct expansion joints.
(6) Combustion turbine exhaust temperatures are high enough to ignite and sustain the basic iron fire oxidation reaction.

8.9.2 Purge.

8.9.2.1 Unfired HRSG.

8.9.2.1.1 A purge of both the HRSG enclosure and the bypass system shall be completed as required in 8.8.4 prior to the admission of combustion turbine exhaust gas into the HRSG.

8.9.2.1.2 Following the purge as required in 8.9.2.1.1, it shall be permitted to interrupt the flow through the HRSG using the bypass stack.

8.9.2.1.3 Combustion turbine exhaust flow shall be permitted to re-enter the HRSG at a later time without repurging, provided the combustion turbine has been in continuous operation with no trips or misfires.

8.9.2.1.4 Where HRSG isolation is maintained and the combustion turbine operation has been interrupted, the combustion turbine shall be permitted to purge and operate with combustion turbine exhaust through the bypass stack.

8.9.2.1.4.1 When it is desired to return the HRSG to service, a purge of the HRSG enclosure shall be performed as required by 8.9.2.1.1.

8.9.2.1.4.2 After the purge of 8.9.2.1.4.1, an interruption as allowed by 8.9.2.1.2 shall be permitted.

8.9.2.1.4.3 Where the combustion turbine operation has been interrupted and it is desired to return the HRSG to service, the combustion turbine shall be permitted to continue operating and the combustion turbine exhaust shall be permitted to be used to purge the HRSG, provided the exhaust temperature is at least 56°C (100°F) lower than the autoignition temperature of the fuels designed for use in the specific combustion turbine.

8.9.2.2 Fired HRSG.

8.9.2.2.1 A purge of both the HRSG enclosure and the bypass system shall be completed as required in 8.8.4 prior to the admission of combustion turbine exhaust gas into the HRSG.

8.9.2.2.2 Where HRSG isolation is continuously maintained and the combustion turbine operation is interrupted, the combustion turbine shall be permitted to purge and operate with combustion turbine exhaust through the bypass stack.

8.9.2.2.2.1 When HRSG isolation is removed, a purge of the HRSG enclosure shall be performed as required by 8.9.2.2.1, except as permitted in 8.9.2.2.4.

8.9.2.2.2.2 Where the combustion turbine operation has been interrupted and it is desired to return the HRSG to service, the combustion turbine shall be permitted to continue operating and the combustion turbine exhaust shall be permitted to be used to purge the HRSG, provided the exhaust temperature is at least 56°C (100°F) lower than the autoignition temperature of the fuels designed for use in the specific combustion turbine and the duct burner.

8.9.2.2.2.3 Where the combustion turbine has been in continuous operation with no trips or misfires and it is desired to

return the HRSG to service, the combustion turbine shall be permitted to continue to be operated and the combustion turbine exhaust may be used to purge the HRSG, provided the exhaust temperature is at least 56°C (100°F) lower than the autoignition temperature of the fuels designed for use in the duct burner.

8.9.2.2.3 If damper(s) operation or other cause(s) results in the exhaust mass flow through the HRSG falling below the purge rate required in 8.8.5, a repurge as required in 8.8.5 shall be performed prior to lighting the duct burner.

8.9.2.2.4* When it is desired that the HRSG be bypassed for a period of time and then for the HRSG to be returned to service by means of damper positioning without a power interruption, one of the following conditions shall be met:

(1) A continuous flow of at least the purge rate of exhaust or fresh air shall be maintained through the HRSG when the combustion turbine is operating.
(2) The combustion turbine is in operation without trips or misfires and the duct burner fuel system satisfies the isolation requirements for a combustion turbine purge credit in accordance with 8.8.4.6.

8.9.2.3* Returning HRSG to Service. Where combustion turbine exhaust flow is to be reintroduced to the HRSG through operation of the stack diverter damper, the combustion turbine load and damper sequence of operation shall be in accordance with the HRSG manufacturer's operating instructions.

8.9.3 Dampers.

8.9.3.1 The requirements of 8.9.3 shall apply regardless of physical hardware [i.e., single-bladed diverting damper, two separate dampers (single or multiblade) for isolation or bypass service, or multiple dampers in series with seal air provision].

8.9.3.2 Damper System.

8.9.3.2.1 The bypass damper failure mode shall be determined, and the exposed system shall be capable of withstanding the resultant pressure.

8.9.3.2.2 A means shall be provided for recognizing leakage of combustion turbine exhaust gas past a closed damper and into the HRSG enclosure.

8.9.3.2.3 Where leakage is detected, the HRSG shall be purged at a temperature at least 56°C (100°F) below the autoignition temperature of the fuel before hot combustion turbine gases are allowed to enter the HRSG enclosure.

8.9.3.2.4 Where leakage results in a HRSG enclosure temperature above the temperature required to ignite and sustain an iron fire oxidation reaction *(see 8.5.5)*, safeguards shall be taken to maintain water supply to the HRSG for tube cooling.

8.9.3.2.5 When HRSG isolation or diverter dampers are utilized, duct burner liquid fuel elements shall be scavenged prior to isolation of the HRSG.

8.9.3.2.6 HRSG isolation shall be provided if either of the following operating conditions are encountered:

(1) Work within the HRSG enclosure is necessary while the combustion turbine is exhausting through the bypass stack.
(2) The HRSG is devoid of water while the combustion turbine is exhausting through the bypass stack except when the HRSG is specifically designed by the HRSG manufacturer to run dry.

8.9.3.2.7 The HRSG enclosure shall be proven free of combustible materials, or the HRSG enclosure that is downstream of the HRSG isolation damper shall be purged to meet the requirements of 8.8.4.

8.9.3.2.8 Where shutoff dampers are utilized, a means to prevent combustible fuel accumulation upstream of the damper shall be provided.

8.9.3.2.9 When HRSG isolation has been implemented, all fuel sources to the duct burner shall be secured using lockout and tag-out procedures.

8.9.3.2.10 During scheduled maintenance outages, the owner or operator shall perform the following inspections and tests:

(1) Inspect the damper system for tightness when the damper(s) is fully closed.
(2) Check the damper operating devices for correct operation.
(3) Verify correct damper system positioning by functional test during purge, start-up, and shutdown.

8.9.4 Monitoring.

8.9.4.1 In addition to the requirements in 8.7.2.3, the position of the damper(s) shall be continuously monitored.

8.9.4.2 In addition to the required alarms in 8.7.3.2, reverse flow through a HRSG (airflow from exhaust stack through a HRSG to bypass stack) shall be alarmed if the bypass damper system can be maintained in an intermediate position.

8.9.5 Interlocks.

8.9.5.1 Stack Closure Interlocks.

8.9.5.1.1 To satisfy the stack closure correct interlock *[see 8.4.2.2.1(5)]*, one of the following conditions shall be met:

(1) The bypass damper proven open and the HRSG isolation damper closed
(2) Both the HRSG isolation damper and the stack damper (if provided) proven open
(3) Diverter damper proven open to atmosphere
(4) Diverter damper proven open to HRSG and stack damper (if provided) proven open

8.9.5.1.2 To satisfy the stack closure not correct interlock *(see 8.4.2.2.3)*, either of the following conditions shall be met:

(1) The bypass damper proven closed and the HRSG isolation damper (or stack damper if provided) not proven open
(2) Where a stack damper is provided, the diverter damper proven open to HRSG and stack damper not proven open

8.9.5.1.3 Where the bypass damper, or the HRSG isolation damper and the stack closure damper, is designed to open to prevent pressurization above the design limit of the combustion turbine exhaust system, a stack closure interlock shall not be required.

8.9.5.2 A duct burner master fuel trip shall be initiated if the bypass damper (if provided) is not proven closed or if the diverter damper (if provided) is not proven fully open to the HRSG. *[See 8.7.4.3(2).]*