	16DNS **Product** **Direct-Fired,** **Data** **Double Effect, Hermetic Absorption** **Liquid Chiller/heater** 40, to 1000 Nominal Tons (141 to 3517 kW)

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Sarma Afarin's 16DNS direct-fired, double effect, hermetic absorption liquid chiller/heater offers a viable alternative to traditional electric driven chillers. Fired by natural gas or No.2 oil, the 16DNS reduces costly electricity bills and qualifies for utility rebates and incentives as a gas cooling product. The 16DNS can operate in the heating mode to provide hot water, thereby reducing the size of the required boiler or even eliminating the need for a boiler.

- no CFCs; environmentally friendly
- two-stage high efficiency design reduces energy costs
- fired by clean burning natural gas , N0.2 oil.
- operates as a chiller or heater
- quiet. vibration-free operation
- few moving parts equates to high reliability

Features/Benefits

Direct-fired, double effect absorption provides efficient, economical water chilling or heating with minimal use of electricity.

Cost-effective cooling and heating, Alternative-energy chiller/heater – The 16DNS offers an alternative for building owners who want to avoid the high operating costs associated with electric-driven chillers. Fired by natural gas N0.2 oil, the Sarma Afarin's 16DNS direct fired, double effect, absorption chiller/heater not only reduces or eliminates electric demand, but also allows the owner to take advantage of gas cooling rebates and incentive programs offered by many utility companies. Several configurations of heating mode operation provide hot water for a variety of applications.

High-efficiency, double effect, Absorption cooling cycle – The 16DNS design incorporates a high temperature generator and a low-stage generator double effect) that provide 2 stages of solution reconcentration. As a result of this double-effect cycle, the 16DNS has lower operating costs than single-effect machines. When using natural gas, full load cooling operation results in a COP coefficient of performance) of 1.01 at standard ARI (Air Conditioning and Refrigeration Institute) operating conditions.

Superior part-load performance – The 16DNS's standard concentration control system allows stable, part-load operation at cooling water temperatures as low as 60.8 F (16 C) without the need for a cooling tower bypass. For maximum efficiency, a variable frequency drive pump automatically maintains optimum solution flow to the high- and low-stage generators at all operating conditions. This will result in improved part-load efficiency and eliminate the need for manual setup adjustments of the solution flow. The 16DNS has a continuous operating range from 100% to 25% capacity for gas-fired series and 100% to 30% for oil-fired series, based on minimum fire requirements for the burner.

Operates in the heating mode for additional savings – In the heating mode, the 16DNS can deliver hot water for space heating or other applications to reduce or eliminate dependency on existing or supplemental boilers. Operation in the heating mode can be done instead of cooling mode operation. When operated as a heater, hot water temperatures of 140 F (60 C) are standard and do not require additional components. In the heating mode, the evaporator is used as the heating bundle and the machine is configured as a 2- pipe system with the chilled water nozzles serving as hot water nozzles. Quick changeover from cooling to heating is accomplished by switching the positions of two hand valves, draining the absorber-condenser water circuit, and putting the machine into heating mode by selecting a heating mode operation from the control panel.

Application versatility ideal for new or retrofit applications – Whether intended for replacement of existing chiller and/or boiler systems or for new construction purposes, the 16DNS well suited to meet the needs of most cooling/heating applications for which a supply of natural gas or No. 2 oil is available. The

16DNS's 23 model sizes, spanning a capacity range of 40 to 1000 tons, make the 16DNS direct-fired, double effect, absorption chiller/heater the ideal choice for comfort cooling and /or light industrial applications. Dependable operation, as well as low sound and vibration levels, ensures occupant comfort, even when the machine is installed on upper floors.

Combined use of absorption and electric-driven chillers – Utilizing both absorption and electric chillers in a central plant offers the flexibility to base load one chiller, while using the other to handle peak load requirements. Hybrid chiller systems have proven to be an economical solution for many comfort cooling installations. In many geographical areas, operating the electric chiller as the base loaded machine, while using the absorption chiller during peak load conditions, reduces or avoids electric demand charges. Depending on utility rate structures, the 16DNS direct-fired absorption chiller/heater used in conjunction with an electric-driven chiller may be the most efficient and cost-effective combination available.

Location and installation savings Ease of installation – All 16DNS units are completely fabricated, assembled, and wired in the factory as single-piece units. Standard shipping configuration is 1 piece. Refer to the 16DNS Standard Shipping Configuration table below.

16DNS STANDARD SHIPPING CONFIGURATION

UNIT SIZE	1-PIECE ASSEMBLY	2-PIECE ASSEMBLY	BURNER/GAS TRAIN ASSEMBLY
004-050	X		Factory installed
055-100		X	Field Installed

Factory-installed burner – Every 16DNS machine through 500 tons is shipped from the factory with the burner, refractory assembly, and gas train installed in the high-stage generator to simplify the chiller/heater installation. This facilitates easier and quicker installation and reduces jobsite costs. It also ensures that all burner-related components are properly installed and wired to the main chiller center for proper control.

Single-point box electrical connection – Installation costs are further reduced by eliminating field wiring between machine components. On units shipped as a single assembly, all unit-mounted electrical items, including the burner control center, are factory-wired to the chiller microprocessor control center. Only a single-point electrical connection to the machine from the building's electrical service is required. When units are shipped in multiple pieces, a wiring harness is provided for interconnection between the burner control center and chiller control center. A multi-tap transformer, mounted in the chiller control center, provides secondary, single-phase power for the 16DNS controls.

Low noise and vibration allows location flexibility –
Low sound and vibration levels are characteristic of absorption chillers, primarily due to the fact that the only rotating parts are the refrigerant and solution pumps. The overall sound level of a Sarma Afarin's 16DNS is typically 80 dbA. This allows the machines to be installed near occupied spaces or in areas with strict sound requirements. Low vibration levels also make it possible to install the chiller/heater on upper floors without special consideration for vibration dampening systems.
The 16DNS004—050 machines are shipped completely for 1-piece shipment. On 16DNS 004-050 machines, the burner and gas train are installed at the factory to minimize field assembly. Job-site reassembly and alignment of machines shipped in multiple sections is simplified by pre-erecting the machine in the factory and by incorporating weld-type assembly flanges on all interconnecting piping

Low maintenance standard features allow simple maintenance procedures – Every 16DNS machine has numerous standard design features that provide for convenient and simple maintenance. Hinged water-box cover on the absorber and condenser facilitate tube and waterbox inspection. A flange type refractory door on the high-stage generator simplifies inspection and cleaning of the combustion chamber and fire tubes. In addition, coating of the waterboxes and covers, standard on all machines, protects against corrosion and extends machine life. All moving parts are easily accessible for inspection or replacement, as required.

Leak-proof hermetic pumps/motors cut maintenance costs – 16DNS's solution and refrigerant pumps/motors are leak-proof, completely self-contained, and hermetically sealed. The hermetic design eliminates the need for a separate, complicated, and possibly leak-prone seal water system while providing leak tightness and longer machine life. Specially designed bearings absorb both radial and axial thrusts to ensure correct fit at all times. There is no possibility of external contamination since the fluid being pumped lubricates and cools the pump and motor assemblies. In addition, both the rotor and the stator are separated by a stainless steel liner that protects the windings from the fluid being pumped. As an additional safety feature, thermal overload switches are embedded in the stator to protect against high winding temperatures. The pumps are field serviceable.

Reliable operation, Microprocessor control center continuously monitors machine operation, ensuring precise control – Each Sarma Afarin's 16DNS direct-fired chiller/heater includes a factory mounted and wired microprocessor control center that is functionally tested prior to shipment. Continuous monitoring and control of machine operation are performed automatically. A multi-language display on the front of the control center identifies operational status and fault indication. The control panel includes a microprocessor CPU (central processing unit) board, molded case circuit breaker, pump cont actors, ambient compensated 3-phase pump overload protection multi-tap control power transformer, and all other necessary safeties and controls. As part of the start-up sequence, the chiller microprocessor control center and the burner combustion controller initiate a self-diagnostic system check to verify that all sensors are in range. Other standard features include a remote start/stop switch and a key-locked control center door that protects against unauthorized access.

Superior corrosion protection – Absorption chillers must be protected from the possibility of internal corrosion that is always present when lithium bromide solution is in contact with internal machine surfaces. The Sarma Afarin's 16DNS absorption chiller/heater incorporates a highly effective corrosion inhibitor to provide an extra margin of protection against internal corrosion. Other inhibitors may require the use of exotic tube materials in certain heat exchangers since they are less effective and require frequent maintenance and analysis. The superior corrosion protection of the Sarma Afarin's inhibitor allows for the use of standard copper tubes throughout the machine (except for the high-temperature generator fire tubes that are made of carbon steel and the high temperature solution heat exchanger tubes made of cupronickel). This results in long machine life and dependable operation.

Rugged machine construction – Every Sarma Afarin's 16DNS chiller/heater offers numerous standard features designed to provide reliable, trouble-free operation. The machine is fabricated to meet stringent manufacturing and design requirements. Non-clogging, corrosion proof spray nozzle protect the16DNS from corrosion and blockage for continues, reliable operation. Horizontally-positioned, carbon steel fire tubes with flue gas on the inside and lithium bromide on the outside are located above the combustion chamber to allow easy soot removal and tube cleaning. This design feature also prevents the flame inside the combustion chamber direct contact with the fire tubes to ensure maximum life and reliability.

Purge system extends machine life and ensure optimum efficiency and performance – The purge system of an absorption chiller is critical to ensuring efficient operation and long machine life. Even when machines are vacuum tight or properly inhibited, all absorption chillers generate hydrogen and other non-condensable gases in small quantities. Since these gases are present in sufficient volume to interfere with proper machine operation, they must be removed to protect the unit from internal corrosion, lithium bromide solution crystallization, and/or a reduction in chiller capacity. Sarma Afarin's purge system protects 16DNS machines from these potential hazards by working continuously during machine operation.

Anti-crystallization controls maintain proper solution concentration – The 16DNS automatically limits solution concentration in several ways to avoid both crystallization and over-dilution to provide dependable, trouble-free operation. Crystallization of the lithium bromide solution depends on the combination of temperature and concentration. Sarma Afarin's concentration control system automatically monitors the refrigerant water level in the evaporator in conjunction with the solution temperature returning to the absorber. Because concentration varies with the amount of water in the lithium bromide solution, a rising evaporator level indicates less water in the solution and thus a higher solution concentration. When the refrigerant in the evaporator rises to a weir level, water is transferred from the evaporator to the absorber thus preventing overconcentration to ensure continuous, reliable operation even at cooling water temperature as low as 60.8 F (16 C). Over-dilution (and possible refrigerant pump cavitations) shall be controlled by transferring an additional amount of refrigerant from the condenser to the evaporator

The 16DNS also incorporates a simple, passive method of control to correct any crystallization that would typically start to occur on the shell side of the low temperature solution heat exchanger under abnormal conditions. As the hot solution begins to back up in the generator, as a result of any shell side blockage, it rises above the overflow pipe and returns directly to the absorber. It is subsequently pumped through the tube side (heating the shell side) to restore proper operation.

In addition, the 16DNS automatic dilution cycle ensures proper concentration after unit shutdown so that the unit will not crystallize when the machine cools to ambientor machine room temperature. The dilution cycle controls operation of the pumps for a set period of time after shutdown to dilute the solution to prevent an overconcentration

16DNS direct-fired, double effect, absorption cooling cycle – The 16DNS direct-fired double effect, absorption chiller/heater consists of an evaporator, absorber, condenser, high- and low-temperature generators, solution heat exchangers, refrigerant/solution pumps, burner and gas train assembly, purge, controls and auxiliaries. Water is used

as the refrigerant in vessels maintained under low absolute pressure (vacuum). In the cooling mode, the chiller operates on the principle that under vacuum, water boils at a low temperature.

In this case water boils at approximately 40 F (4.4 C), thereby cooling the chilled water circulating through the evaporator tubes. A refrigerant pump is used to circulate the refrigerant water over the evaporator tubes to improve heat transfer.

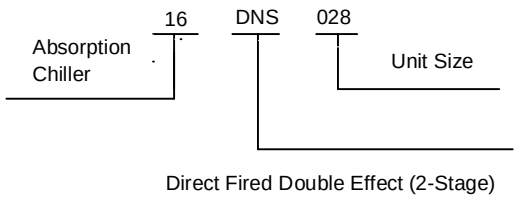
To make the cooling process continuous, the refrigerant vapor must be removed as it is produced. To accomplish this, a lithium bromide solution (which has a high affinity for water) is used to absorb the water vapor. As this process continues, the lithium bromide becomes diluted, reducing its absorption capacity. A solution pump then transfers this weak (diluted) solution to the generators where it is reconcentrated in 2 stages to boil off the previously absorbed water. A variable frequency drive pump automatically maintains optimum solution flow to the generators at all operating conditions for maximum efficiency. The diluted solution is pumped to the high-temperature generator where it is heated and reconcentrated to a medium concentration solution by the heat from the combustion of natural gas , N0.2 oil. The medium concentration solution from the high-stage generator flows to the low-stage generator where it is heated and reconcentrated to a strong solution by the high temperature water vapor released from the solution in the high-temperature generator.

Since the low-stage generator acts as the condenser acts for the high-temperature generator, the heat energy first applied in the high-temperature generator is used again in the low-temperature generator thus reducing the heat input by approximately 45% as compared to an absorption chiller with a single stage of reconcentration. The water vapor released in the shell side of the low-temperature generator, in addition to the now condensed water vapor from the tube side of the low temperature generator, enters the condenser to be cooled and returned to a liquid state. The refrigerant water then returns to the evaporator to begin a new cycle.

To remove heat from the machine, relatively cool water from a cooling tower or other source is first circulated through the tubes of the absorber to remove the heat of vaporization. The water is then circulated through the tubes of the condenser. The strong (reconcentrated) solution from the low-temperature generator flows back to the absorber to begin a new cycle. For efficiency reasons, the medium concentration solution from the high-temperature generator is passed through the high temperature solution heat exchanger to pre-heat the weak solution, while pre-cooling the medium concentration solution. The strong solution from the low-temperature generator is passed through the low-temperature solution heat exchanger to preheat/precool the solution before being returned to the absorber.

16DNS direct-fired, double effect, absorption heating cycle – The 16DNS direct-fired, double effect, absorption chiller/heater can also be operated in a non-simultaneous heating (only) mode to provide 140 F (60 C) hot water for space heating or other purposes without any additional components. In this mode, the cycle follows a different vapor flow path than that undertaken for cooling and does not use the absorption process. In addition, the absorber-condenser cooling water circuit is drained, and thus not operated, since all heat rejection from the machine is designed to take place through the evaporator (now the heating bundle) in a classic 2- pipe system which utilizes only the evaporator nozzles. High temperature water vapor produced in the high-temperature generator section is passed directly to the evaporator via absorber where it condenses and transfers its heat to the water circulating through the evaporator tubes. This condensed water then flows to the absorber section where it mixes with the concentrated solution returning from the high-temperature generator. The diluted solution is then pumped back to the high-temperature generator to repeat the vapor generation phase for the heating function..

Model number nomenclature



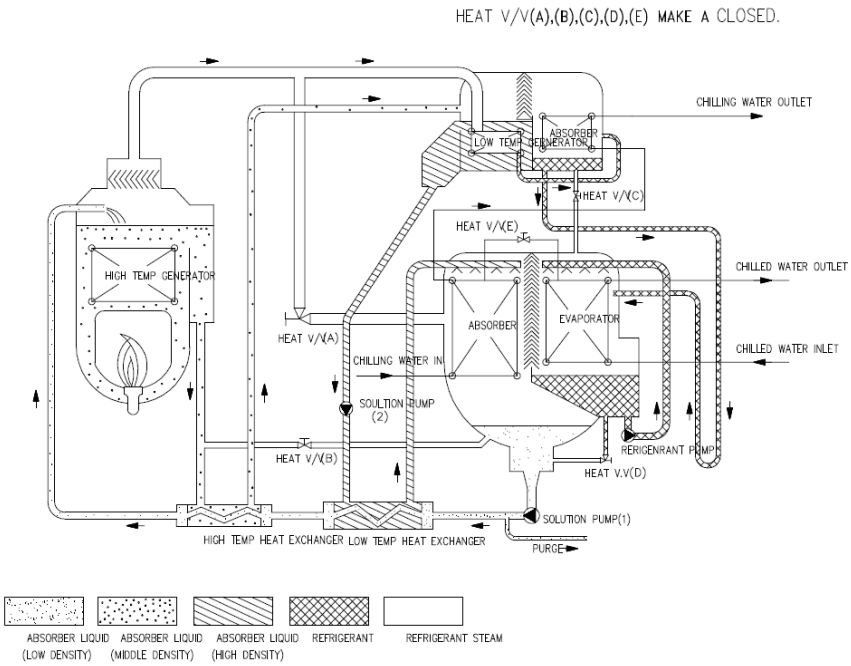
Machine components

TYPICAL 16DNS

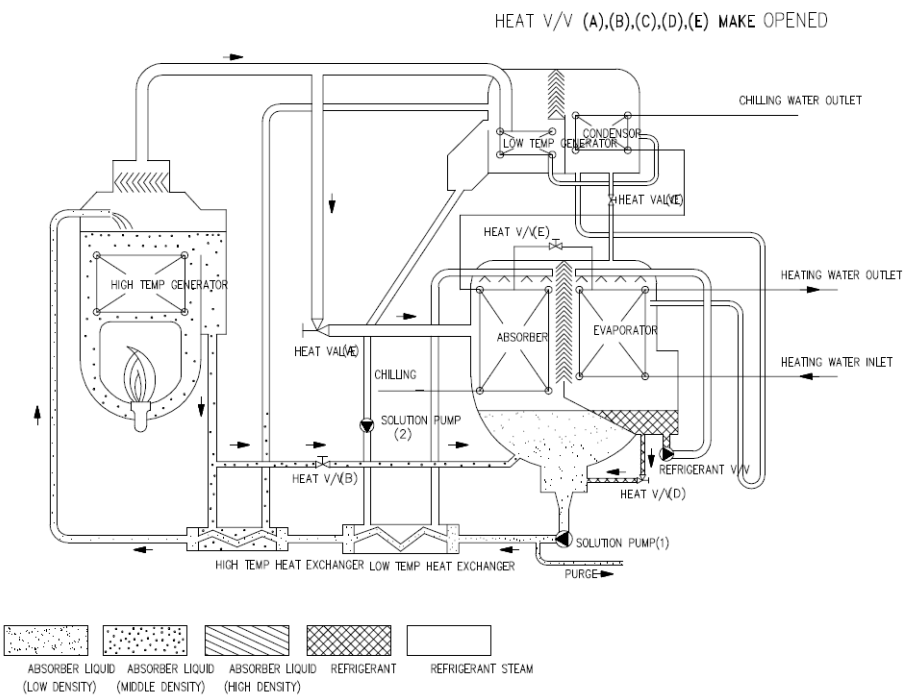
LEGEND

1 – Low-Temperature Generator
2 – High-Temperature Generator
3 – Exhaust Gas Outlet
4 – Burner Assembly and Control Center
5 – Chiller/Heater Control Center
6 – Solution Heat Exchanger
7 – Absorber
8 – Evaporator
9 – Condenser

16DNS ABSORPTION COOLING CYCLE



16DNS ABSORPTION HEATING CYCLE (140F\[60C])



Physical data

ENGLISH

Unit 16DNS		004	005	006	007	008	010	013	015
NOMINAL COOLING CAPACITY	ton	40	50	60	70	80	100	130	150
RIGGING WEIGHT	lb	5,952	6,393	6,834	7,716	8,157	12,787	14,330	16,314
OPERATING WEIGHT	lb	6,614	7,055	7,496	8,378	8,818	13,889	15,432	17,637
CHILLED/HOT WATER (Evaporator) Pipe Connection Size	in	3	3	3	3	3	4	4	5
COOLING WATER Pipe Connection Size	in	4	4	4	4	4	5	5	6
GAS-TRAIN INLET Pipe Connection Size, NPT	in	1 1/2	1 1/2	1 1/2	1 1/2	1 1/2	1 1/2	1 1/2	1.1/2
EXHAUST GAS OUTLET Nominal Flange Connection Size	in x in	7.5x4.5	7.5x4.5	7.5x4.5	10.5x5	10.5x5	10x8	10x8	11×9

Unit 16DNS		018	021	024	028	032	036	040	045
NOMINAL COOLING CAPACITY	ton	180	210	240	280	320	360	400	450
RIGGING WEIGHT	lb	17,857	19,401	20,062	23,149	25,574	26,676	27,999	29,321
OPERATING WEIGHT	lb	19,401	21,385	22,267	25,574	28,440	30,203	31,526	33,731
CHILLED/HOT WATER (Evaporator) Pipe Connection Size	in	5	5	5	6	6	6	6	8
COOLING WATER Pipe Connection Size	in	6	6	6	8	8	8	8	10
GAS-TRAIN INLET Pipe Connection Size, NPT	in	2	2	2	2	2 1/2	2 1/2	2 1/2	2 1/2
EXHAUST GAS OUTLET Nominal Flange Connection Size	in x in	11x9	13.5x 10	13.5x 10	15x12	15x12	16.5x 13.5	16.5x 13.5	21x18

Unit 16DNS		050	055	060	070	080	090	100
NOMINAL COOLING CAPACITY	ton	500	550	600	700	800	900	1000
RIGGING WEIGHT	lb	31,085	45,636	49,383	52,249	64,816	70,107	75,618
OPERATING WEIGHT	lb	35,494	51,588	55,777	59,304	73,855	79,587	85,760
CHILLED/HOT WATER (Evaporator) Pipe Connection Size	in	8	8	8	8	10	10	10
COOLING WATER Pipe Connection Size	in	10	12	12	12	14	14	14
GAS-TRAIN INLET Pipe Connection Size, NPT	in	2 1/2	2 1/2	2 1/2	2 1/2	2 1/2	2 1/2	2 1/2
EXHAUST GAS OUTLET Nominal Flange Connection Size	in x in	21x18	21x18	21x18	26x18	26x18	26x18	26x18

Physical data

SI

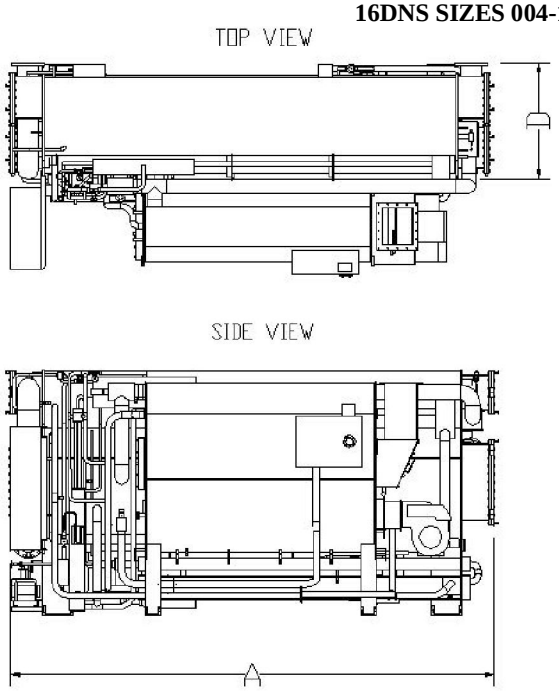
Unit 16DNS		004	005	006	007	008	010	013	015
NOMINAL COOLING CAPACITY	kW	141	176	211	246	281	352	457	527
RIGGING WEIGHT	kg	2,700	2,900	3,100	3500	3,700	5,800	6,500	7,400
OPERATING WEIGHT	kg	3,000	3,200	3,400	3,800	4,000	6,300	7,000	8,000
CHILLED/HOT WATER (Evaporator) Pipe Connection Size	mm	80	80	80	80	80	100	100	125
COOLING WATER Pipe Connection Size	mm	100	100	100	100	100	125	125	150
GAS-TRAIN INLET Pipe Connection Size, NPT	mm	40	40	40	40	40	40	40	40
EXHAUST GAS OUTLET Nominal Flange Connection Size	mm x mm	190x110	190x110	190x110	270x150	270x150	252x202	252x202	282x232

Unit 16DNS		018	021	024	028	032	036	040	045
NOMINAL COOLING CAPACITY	kW	633	739	844	985	1,125	1,266	1,407	1,583
RIGGING WEIGHT	kg	8,100	8,800	9,100	10,500	11,600	12,100	12,700	13,300
OPERATING WEIGHT	kg	8,800	9,700	10,100	11,600	12,900	13,700	14,300	15,300
CHILLED/HOT WATER (Evaporator) Pipe Connection Size	mm	125	125	125	150	150	150	150	200
COOLING WATER Pipe Connection Size	mm	150	150	150	200	200	200	200	250
GAS-TRAIN INLET Pipe Connection Size, NPT	mm	50	50	50	50	65	65	65	65
EXHAUST GAS OUTLET Nominal Flange Connection Size	mm x mm	282x232	342x262	342x262	382x302	382x302	422x342	422x342	532x452

Unit 16DNS		050	055	060	070	080	090	100
NOMINAL COOLING CAPACITY	kW	1,759	1,934	2,110	2,462	2,814	3,165	3,517
RIGGING WEIGHT	kg	14,100	20,700	22,400	23,700	29,400	31,800	34,300
OPERATING WEIGHT	kg	16,100	23,400	25,300	26,900	33,500	36,100	38,900
CHILLED/HOT WATER (Evaporator) Pipe Connection Size	mm	200	200	200	200	250	250	250
COOLING WATER Pipe Connection Size	mm	250	300	300	300	350	350	350
GAS-TRAIN INLET Pipe Connection Size, NPT	mm	65	65	65	65	65	65	65
EXHAUST GAS OUTLETNominal FlangeConnection Size	mm x mm	532x452	532x452	532x452	652x452	652x452	652x452	652x452

Dimensions

16DNS SIZES 004-100



DIMENSIONS(mm)

Dimensions		004	005	006	007	008	010	013	015	018	021	024	028
Length	mm	2,079	2,079	2,079	2,476	2,476	2,814	3,410	3,850	4,350	3,870	4,370	5,020
Width	mm	1,490	1,490	1,490	1,699	1,699	2,161	2,161	2,200	2,200	2,370	2,370	2,570
Height	mm	1,852	1,852	1,852	1,852	1,852	2,137	2,137	2,300	2,300	2,410	2,410	2,440

DIMENSIONS(mm)

Dimensions		032	036	040	045	050	055	060	070	080	090	100
Length	mm	5,520	5,025	5,525	5,150	5,610	5,060	5,600	6,100	5,710	6,210	6,730
Width	mm	2,570	2,635	2,635	2,650	2,650	3,010	3,010	3,010	3,400	3,400	3,400
Height	mm	2,440	2,550	2,550	2,550	2,550	3,000	3,000	3,000	3,610	3,610	3,610

DIMENSIONS(ft-in)

Dimensions		004	005	006	007	008	010	013	015	018	021	024	028
Length	ft-in	6-10	6-10	6-10	8-1	8-1	9-3	11-2	12-8	14-3	12-8	14-4	16-6
Width	ft-in	4-11	4-11	4-11	5-7	5-7	7-1	7-1	7-3	7-3	7-9	7-9	8-5
Height	ft-in	6-1	6-1	6-1	6-1	6-1	7-0	7-0	7-7	7-7	7-11	7-11	8-0

DIMENSIONS(ft-in)

Dimensions		032	036	040	045	050	055	060	070	080	090	100
Length	ft-in	18-1	16-6	18-2	16-11	18-5	16-7	18-4	20-0	18-9	20-4	22-1
Width	ft-in	8-5	8-8	8-8	8-8	8-8	9-11	9-11	9-11	11-2	11-2	11-2
Height	ft-in	8-0	8-2	8-2	8-4	8-4	9-10	9-10	9-10	11-10	11-10	11-10

NOTES:

1. For routine maintenance, allow 3 ft (1 m) clearance on all sides and 1.5 ft (0.5 m) above chiller.
2. For tube removal, allow space equal to the length at either end of the chiller.

Performance data

ENGLISH

Unit 16DNS		004	005	006	007	008	010	013	015
COOLING CAPACITY	ton	40	50	60	70	80	100	130	150
HEATING CAPACITY	MBh	578	722	865	1,008	1,155	1,004	1,255	1,506
CHILLED WATER									
Flow Rate	gpm	106.5	133.0	159.8	186.7	213.3	266.4	332.9	399.3
Pressure Drop	ft	9.2	9.8	10.8	7.9	8.2	13.1	19.7	16.4
COOLING WATER									
Flow Rate	gpm	176.1	220.1	264.2	308.2	352.2	440.3	550.4	660.4
Pressure Drop	ft	14.1	14.8	16.4	12.5	13.1	15.1	24.6	18.0
HOT WATER									
Flow Rate	gpm	106.5	133.0	159.8	186.7	213.3	266.4	332.9	399.3
Pressure Drop	ft	9.2	9.8	10.8	7.9	8.2	13.1	19.7	16.4
FUEL CONSUMPTION									
Natural Gas, Cooling Mode	ft^3/h	409.7	512.1	614.5	716.9	819.3	971.2	1,214.8	1,455.0
Natural Gas, Heating Mode	ft^3/h	561.5	702.8	844.0	981.7	1,123.0	950.0	1,190.1	1,426.7
Oil, Cooling Mode	lb/h	27.3	34.2	40.8	47.6	49.4	60.4	75.4	90.6
Oil, Heating Mode	lb/h	36.2	45.2	54.2	63.3	67.9	60.4	75.4	90.6

Unit 16DNS		018	021	024	028	032	036	040	045
COOLING CAPACITY	ton	180	210	240	280	320	360	400	450
HEATING CAPACITY	MBh	1,807	2,108	2,410	2,811	3,213	3,614	4,016	4,516
CHILLED WATER									
Flow Rate	gpm	479.5	559.2	639.3	745.4	852.0	958.5	1,065.1	1,198.5
Pressure Drop	ft	22.3	16.4	20.3	13.1	16.4	13.1	18.0	27.9
COOLING WATER									
Flow Rate	gpm	792.5	924.6	1,056.7	1,232.8	1,408.9	1,585.0	1,761.1	1,981.3
Pressure Drop	ft	27.2	21.3	24.6	19.7	27.9	19.7	27.9	34.4
HOT WATER									
Flow Rate	gpm	479.5	559.2	639.3	745.4	852.0	958.5	1,065.1	1,198.5
Pressure Drop	ft	22.3	16.4	20.3	13.1	16.4	13.1	18.0	27.9
FUEL CONSUMPTION									
Natural Gas, Cooling Mode	ft^3/h	1,748.1	2,037.7	2,330.8	2,719.2	3,107.7	3,496.2	3,884.6	4,368.4
Natural Gas, Heating Mode	ft^3/h	1,712.8	1,998.8	2,284.9	2,666.3	3,044.1	3,429.1	3,806.9	4,283.7
Oil, Cooling Mode	lb/h	108.7	126.8	145.1	169.1	193.3	217.4	241.6	271.8
Oil, Heating Mode	lb/h	108.7	126.8	145.1	169.1	193.3	217.4	241.6	271.8

Unit 16DNS		050	055	060	070	080	090	100
COOLING CAPACITY	ton	500	550	600	700	800	900	1000
HEATING CAPACITY	MBh	5,020	5,622	6,325	7,028	8,032	9,036	10,040
CHILLED WATER								
Flow Rate	gpm	1,331.4	1,464.4	1,597.8	1,864.2	2,130.1	2,396.5	2,662.9
Pressure Drop	ft	31.2	17.1	22.0	28.9	15.7	21.3	27.9
COOLING WATER								
Flow Rate	gpm	2,201.4	2,421.6	2,641.7	3,082.0	3,522.3	3,962.6	4,402.9
Pressure Drop	ft	36.1	27.2	36.1	46.6	28.2	37.1	47.6
HOT WATER								
Flow Rate	gpm	1,331.4	1,464.4	1,597.8	1,864.2	2,130.1	2,396.5	2,662.9
Pressure Drop	ft	31.2	17.1	22.0	28.9	15.7	21.3	27.9
FUEL CONSUMPTION								
Natural Gas, Cooling Mode	ft^3/h	4,855.8	5,339.6	5,823.4	6,794.5	7,765.7	8,736.9	9,708.0
Natural Gas, Heating Mode	ft^3/h	4,760.4	5,297.2	5,996.4	6,663.9	7,617.4	8,567.3	9,520.8
Oil, Cooling Mode	lb/h	302.0	339.5	381.4	423.3	482.8	542.3	601.9
Oil, Heating Mode	lb/h	302.0	339.5	381.4	423.3	482.8	542.3	601.9

NOTE: Ratings are based on ARI 560, latest edition, 53.6/44.6 °F chilled water; 129.2/140 °F hot water; 90 °F cooling water; fouling factor 0.00025 ft^2-hr-°F/Btu for absorber and condenser, 0.0001 ft^2-hr-°F/Btu for evaporator; natural gas heating value 1,236 Btu/ft^3 (HHV); no 2 oil heating value 154,720 Btu/gal.

Performance data (cont)

SI

Unit 16DNS		004	005	006	007	008	010	013	015
COOLING CAPACITY	kW	141	176	211	246	281	352	457	528
HEATING CAPACITY	kW	169	212	254	295	338	294	368	441
CHILLED WATER									
Flow Rate	l/s	6.7	8.4	10.1	11.8	13.5	16.8	21.0	25.2
Pressure Drop	m	2.8	3	3.3	2.4	2.5	4	6	5
COOLING WATER									
Flow Rate	l/s	11.1	13.9	16.7	19.4	22.2	27.8	34.7	41.7
Pressure Drop	m	4.3	4.5	5	3.8	4	4.6	7.5	5.5
HOT WATER									
Flow Rate	l/s	6.7	8.4	10.1	11.8	13.5	16.8	21.0	25.2
Pressure Drop	m	2.8	3	3.3	2.4	2.5	4	6	5
FUEL CONSUMPTION									
Natural Gas, Cooling Mode	m^3/h	11.6	14.5	17.4	20.3	23.2	27.5	34.4	41.2
Natural Gas, Heating Mode	m^3/h	15.9	19.9	23.9	27.8	31.8	26.9	33.7	40.4
Oil, Cooling Mode	kg/h	12.4	15.5	18.5	21.6	22.4	27.4	34.2	41.1
Oil, Heating Mode	kg/h	16.4	20.5	24.6	28.7	30.8	27.4	34.2	41.1

Unit 16DNS		018	021	024	028	032	036	040	045
COOLING CAPACITY	kW	633	739	844	985	1,125	1,266	1,407	1,583
HEATING CAPACITY	kW	530	618	706	824	942	1,059	1,177	1,323
CHILLED WATER									
Flow Rate	l/s	30.3	35.3	40.3	47.0	53.8	60.5	67.2	75.6
Pressure Drop	m	6.8	5	6.2	4	5	4	5.5	8.5
COOLING WATER									
Flow Rate	l/s	50.0	58.3	66.7	77.8	88.9	100.0	111.1	125.0
Pressure Drop	m	8.3	6.5	7.5	6	8.5	6	8.5	10.5
HOT WATER									
Flow Rate	l/s	30.3	35.3	40.3	47.0	53.8	60.5	67.2	75.6
Pressure Drop	m	6.8	5	6.2	4	5	4	5.5	8.5
FUEL CONSUMPTION									
Natural Gas, Cooling Mode	m^3/h	49.5	57.7	66	77	88	99	110	123.7
Natural Gas, Heating Mode	M^3/h	48.5	56.6	64.7	75.5	86.2	97.1	107.8	121.3
Oil, Cooling Mode	kg/h	49.3	57.5	65.8	76.7	87.7	98.6	109.6	123.3
Oil, Heating Mode	kg/h	49.3	57.5	65.8	76.7	87.7	98.6	109.6	123.3

Unit 16DNS		050	055	060	070	080	090	100
COOLING CAPACITY	kW	1,759	1,934	2,110	2,462	2,814	3,165	3,517
HEATING CAPACITY	kW	1,471	1,648	1,854	2,060	2,354	2,648	2,942
CHILLED WATER								
Flow Rate	l/s	84.0	92.4	100.8	117.6	134.4	151.2	168.0
Pressure Drop	m	9.5	5.2	6.7	8.8	4.8	6.5	8.5
COOLING WATER								
Flow Rate	l/s	138.9	152.8	166.7	194.4	222.2	250.0	277.8
Pressure Drop	m	11	8.3	11	14.2	8.6	11.3	14.5
HOT WATER								
Flow Rate	l/s	84.0	92.4	100.8	117.6	134.4	151.2	168.0
Pressure Drop	m	9.5	5.2	6.7	8.8	4.8	6.5	8.5
FUEL CONSUMPTION								
Natural Gas, Cooling Mode	m^3/h	137.5	151.2	164.9	192.4	219.9	247.4	274.9
Natural Gas, Heating Mode	m^3/h	134.8	150	169.8	188.7	215.7	242.6	269.6
Oil, Cooling Mode	kg/h	137	154	173	192	219	246	273
Oil, Heating Mode	kg/h	137	154	173	192	219	246	273

NOTE: Ratings are based on ARI 560, latest edition;12/7 °C chilled water, 32 °C cooling water; 54/60 C hot water; fouling factor 0.000044 m^2-hr-°C/W absorber and condenser, 0.0000176 m^2-hr-°C/W for evaporator; natural gas heating value 11,000 kcal/m^3 (HHV); No 2 oil heating value 10,300 kcal/l.

Electrical Data

Unit 16 DNS		004	005	006	007	008	010	013	015
SOULTION PUMP(1)	kW(A)	1.2 (3.0)	1.2 (3.0)	1.2 (3.0)	1.2 (3.0)	1.2 (3.0)	2.0(6.1)	2.0(6.1)	2.4(6.4)
SOULTION PUMP(2)	kW(A)	-	-	-	-	-	-	-	0.7(3.0)
REF PUMP	kW(A)	0.2 (1.1)	0.2 (1.1)	0.2 (1.1)	0.2 (1.1)	0.2 (1.1)	0.3(1.5)	0.3(1.5)	0.3(1.5)
PURGE PUMP	kW(A)	0.4 (1.3)	0.4 (1.3)	0.4 (1.3)	0.4 (1.3)	0.4 (1.3)	0.4 (1.3)	0.4 (1.3)	0.75(2.1)
BURNER'S BLOWER(GAS)	kW(A)	0.37 (1.1)	0.37 (1.1)	0.37 (1.1)	0.74 (2.3)	0.74 (2.3)	1.5(3.5)	1.5(3.5)	1.5(3.5)
BURNER'S BLOWER(OIL)	kW(A)	-	-	-	-	-	1.5(2.2)	1.5(2.2)	2.2(4.8)

Unit 16 DNS		018	021	024	028	032	036	040	045
SOULTION PUMP(1)	kW(A)	2.4(6.4)	3.2(9.5)	3.2(9.5)	3.4(10.3)	3.4(10.3)	5.5(15.3)	5.5(15.3)	6.6(21.5)
SOULTION PUMP(2)	kW(A)	0.7(3.0)	0.9(3.2)	0.9(3.2)	1.5(4.6)	1.5(4.6)	1.5(4.6)	1.5(4.6)	1.5(4.6)
REF PUMP	kW(A)	0.3(1.5)	0.75(2.8)	0.75(2.8)	1.5(3.9)	1.5(3.9)	1.5(3.9)	1.5(3.9)	1.5(3.9)
PURGE PUMP	kW(A)	0.75(2.1)	0.75(2.1)	0.75(2.1)	0.75(2.1)	0.75(2.1)	0.75(2.1)	0.75(2.1)	0.75(2.1)
BURNER'S BLOWER(GAS)	kW(A)	1.5(3.5)	1.5(3.5)	2.2(5.0)	2.2(8.2)	2.2(8.2)	2.2(8.2)	3.7(13.4)	3.7(13.4)
BURNER'S BLOWER(OIL)	kW(A)	2.2(4.8)	2.2(4.8)	3.7(7.6)	6.25(12.6)	6.25(12.6)	6.25(12.6)	6.25(12.6)	6.25(12.6)

Unit 16 DNS		050	055	060	070	080	090	100
SOULTION PUMP(1)	kW(A)	6.6(21.5)	6.6(21.5)	6.6(21.5)	6.6(21.5)	6.6(21.5)	7.5(25.0)	7.5(25.0)
SOULTION PUMP(2)	kW(A)	1.5(4.6)	2.0(6.1)	2.0(6.1)	2.2(6.4)	2.2(6.4)	2.2(6.4)	2.2(6.4)
REF PUMP	kW(A)	1.5(3.9)	2.0(5.2)	2.0(5.2)	2.0(5.2)	2.0(5.2)	2.0(5.2)	2.0(5.2)
PURGE PUMP	kW(A)	0.75(2.1)	0.75(2.1)	0.75(2.1)	0.75(2.1)	0.75(2.1)	0.75(2.1)	0.75(2.1)
BURNER'S BLOWER(GAS)	kW(A)	3.7(13.4)	4.0(10.5)	4.0(10.5)	7.5(18.6)	7.5(18.6)	7.5(18.6)	7.5(18.6)
BURNER'S BLOWER(OIL)	kW(A)	6.25 (12.6)	6.25 (12.6)	6.25 (12.6)	7.5(18.6)	7.5(18.6)	7.5(18.6)	7.5(18.6)

NOTES:

1. Electrical data based on 3 Ph, 400 V, 50 Hz power line.
2. Other specifications are available as per request.

Guide specifications

Hermetic Absorption Liquid Chiller/Heater

Size Range: 40 **to 1000 tons (141 to 3517 kW)**
Sarma Afarin's Model Numbers: **16DNS**

Part 1 – General

1.01 SYSTEM DESCRIPTION

Electronically controlled, double-effect (two-stage) absorption liquid chiller/heater utilizing hermetic refrigerant and solution pumps, lithium bromide solution as the absorbent, and water as the refrigerant. The combustion of natural gas or No. 2 oil within the generator shall serve as the heat source.

1.02 QUALITY ASSURANCE

A. Chiller performance shall be rated in accordance with ARI Standard 560 (latest edition).

B. Chiller shall be manufactured in accordance with KSB 6271-1987, which is Korean standard as applicable.

C. Each chiller shall undergo a series of standard factory tests to ensure that the unit is leak tight, that all electrical components operate as intended, and that every aspect of the unit fabrication meets stringent quality standards in accordance with good practice and the manufacturer's quality assurance requirements.

1. The shell side of each chiller shall be leak tested by pressurizing to 11 psig (76 kPa) with nitrogen and then checked by spraying a soap/water mixture on all welds, tube joints, and/or gasketed joints to identify any major leaks. Afterward, a mass spectrometer test shall be performed by evacuating the unit to .001mmHg absolute, covering the machine with a vinyl tent, and introducing helium gas under the tent. Any remaining leaks will allow the helium to be drawn into the shell side of the machine. The acceptable leak rate as measured by the mass spectrometer test shall not exceed 0.00001 cc/sec standard air.

2. The tube side of the evaporator, absorber, and condenser shall be hydrostatically tested at 1.25 times rated design pressure and held for one hour.

3. The refrigerant and solution pump/motors shall undergo standard factory tests to ensure proper head flow, and motor output characteristics.

4. All machine wiring shall undergo an insulation resistance test. The chiller/heater control center and all electrical components shall also be functionally tested to verify continuity and proper electrical operation.

5. Final assembly inspection shall consist of verifying that all valves, controls, instrumentation, pumps, purge components, and all other machine components have been properly installed on the machine.

6. Each unit shall then be checked for overall appearance and dimensional accuracy.

7. Final inspection shall be performed on each unit to check that painting of the unit is as specified, nameplate data is correct, and that all accessories are

1.03 DELIVERY, STORAGE, AND HANDLING

A. Unit shall be stored and handled in accordance with the manufacturer's recommendations.

B. Normally, unit shall be charged with lithium bromide solution at the jobsite in accordance with the manufacturer's written instructions; but if customer requires, unit can be factory-charged with lithium bromide solution and performance tested before shipping as special requirement.

C. One-piece units shall be shipped under vacuum on the shell side.

D. Burner, burner control center and gas train (or oil control system) shall be factory-installed for sizes 16DNS004-050.

E. Chiller shall be shipped with nameplates indicating name of manufacturer, model size, serial number, and all other pertinent machine data.

1.04 WARRANTY

Manufacturer shall guarantee the chiller against defects in materials or workmanship for a period of one year from date of initial operation or 18 months from date of shipment, whichever occurs first. Sarma Afarin's shall provide the labor to repair or replace any part found to be defective in material or workmanship within the warranty period.

Part 2 – Products

2.01 EQUIPMENT

A. General:

Absorption liquid chiller/heater shall include evaporator, absorber, condenser, high- and low-stage generators, solution heat exchanger, burner/gas train (or burner/oil control system) assembly, refrigerant/ solution pumps, purge system, piping, wiring, controls, and auxiliaries. Shipment of the machine shall be in 1 piece with an option for 2-piece shipment. Initial charge of lithium bromide can be included with the chiller/heater for charging at the jobsite. The highstage generator shall be configured such that the fire tubes are horizontally positioned above the combustion chamber with flue gas inside the tube and lithium bromide solution on the outside of the tubes. This design shall simplify the process of tube cleaning and shall prevent the flame from coming into direct contact with the tubes. This shall ensure maximum life and reliability.

B. Operating Characteristics:

1. Chiller operation shall be characteristic of a doubleeffect absorption cycle with series solution flow. The weak solution from the absorber shall be entering the high-stage generator via the low- and the high-temperature solution heat exchangers. A variable frequency drive pump shall automatically regulate the flow of solution to the generators to maintain optimum flow at all operating conditions. This shall result in

improved part-load efficiency and eliminate the need for manual set-up adjustments of the solution flow.
2. Unit shall be capable of continuous operation from 100 to 25% capacity, with entering condenser water temperatures as low as 60.8 F (16 C), without the need for a cooling tower bypass valve. Thermostat ON/OFF control of the cooling tower fan is recommended when cooling water temperature falls below 64 F (18 C).
3. Standard chiller design shall be based on a 2 –pipe system capable of operation in either the cooling or heating mode. When in the heating mode, the evaporator tube bundle shall be utilized as the heating bundle supplying hot water through the standard evaporator nozzle connections to simplify piping. The hot water temperature leaving the unit shall be 140 F (60 C).
C. Heat Exchangers:
1. All heat exchangers shall be of shell and tube construction with shells, tubesheets, tube support sheets, and waterboxes fabricated of carbon steel. All heat exchangers shall incorporate straight tubes. All tubes shall be rolled into grooveless tubesheets and expanded into tube support sheets, except for the high- and low-stage generator tubes. Highstage generator tubes shall be welded into tube sheets. All tubes shall be individually replaceable. Low-stage tubes shall be rolled into grooved tubesheets and expanded into tube support sheets
2. The evaporator, absorber, and condenser waterboxes shall be designed for 150 psig (1034 kPa) working pressure. Nozzle-in-head (NIH) type waterboxes shall be supplied on the evaporator while the absorber-condenser waterboxes shall be either marine type. All waterboxes shall be provided with vent and drain connections. ANSI 150 psig RF flanges shall be furnished on all waterbox nozzle connections.
3. The high-stage generator shall incorporate a cylindrical combustion chamber. The carbon steel (boiler type) fire tubes shall be located above the combustion chamber in a horizontal position and shall be seal welded to the tubesheets. Turbulators shall be provided in each fire tube to increase heat transfer. Access to the high-stage generator shall be provided via a flange type refractory door on the end opposite the burner. A sightglass shall be provided in the chamber to observe flame size and shape. A flanged rectangular flue gas outlet connection shall be located on the burner end above the burner assembly.
4. A high-temperature and a low-temperature solution heat exchanger shall be an integral part of the machine to increase efficiency by pre-heating weak solution on the tubeside with strong solution on the shellside. Tube material for the high-temperature heat exchanger shall be cupronickel, and tube material for the low-temperature heat exchanger shall be copper.
5. Spray heads for the evaporator and absorber shall be of a non-clogging design, specifically designed for the intended duty, and shall be fabricated of a corrosion-proof material to ensure continuous, high-efficiency operation.
6. Heat exchanger tube material and minimum wall thickness shall be contingent on the type of corrosion inhibitor used in the machine. For molybdate systems, the following tube specifications shall apply to ensure long machine life and continuous
operation:
Evaporator: copper, externally-finned
Absorber: copper, corrugated
Condenser: copper, corrugated
Low-Temperature Generator: copper, externally-finned
High-Temperature Generator: carbon steel, prime surface
If chiller manufacturer requires the use of tube materials other than as listed above, due to the use of a less effective inhibitor, the chiller manufacturer shall guarantee performance of the machine for its design life and shall replace tubes and/or tube bundles as necessary during this period at no additional cost to the owner.
D. Pump/Motors:
Refrigerant and solution pump/motors shall be self contained, leak-proof, hermetic type, with isolation valves, and internal seal water system to minimize air leakage into the machine. Lubrication and cooling shall be accomplished by the fluid being pumped; auxiliary water piping for cooling and lubrication shall not be acceptable. Pump/motor assemblies shall be designed for a minimum of 5 years (or 20,000 hours) normal operation between inspections. If pump/motor assemblies are furnished with less than a design of 20,000 hours between inspections, they must be provided with a bearing monitoring system to aid in diagnosing and performing on-going maintenance.
E. Burner Assembly:
1. Burner shall be of the turbo-ring draft type with stainless steel flame retention-type combustion head to assure stable, pulsation-free operation. Primary-secondary air ratio and total air volume shall be manually adjustable to provide control at the firing head for optimum burner efficiency. The burner shall incorporate its own sequence, combustion, supervision, and safety controls but shall operate under the direction of the chiller microprocessor. Interfacing with the chiller control center shall be done via a field-installed wiring harness.
2. The burner assembly and gas train (or oil control system) shall consist of strainers, shutoff valves, regulators, control valves, safety valves, ignition transformers, flame detectors, and pressure switches as necessary to meet national, state, and/or local code requirements. The burner control center shall house the blower motor contactor, overloads, combustion safety controls, and all other components for safe, proper operation.
3. Burner shall be capable of operation on either natural gas, No. 2 oil, or both (dual-fuel). A fuel transfer switch shall be provided on the burner control center to enable switching between gas and oil when configured for dual-fuel operation.
F. Controls:

The 16DNS series chiller contains a microprocessorbased control center that monitors and controls all operations of the machine. The microprocessor controls system matches the cooling capacity of the machine to the cooling load while providing state-of-the-art machine protection. The system controls cooling capacity within the set point plus the deadband by sensing the leaving chilled water and regulating the burner capacity valve via a mechanically linked actuator motor.

G. Machine Safety Devices:

1. Machine safety and limit devices shall be included as follows:

a. High solution level – generator (limit)
b. Low solution level – generator
c. Low chilled water temperature
d. Low chilled water flow
e. Low cooling water flow (optional)
f. High solution temperature – generator
g. High hot water temperature (limit)
h. High flue gas temperature
i. High motor winding temperature – refrigerant/solution pump
j. High motor amperage – refrigerant/solution pump
k. High pressure – generator
l. Low fuel pressure
m. Low combustion airflow
n. Flame failure
o. Low fire at ignition verification

2. Chiller shall include a rupture disk (optional) or a fusible plug to protect against accidental overpressure.

H. Electrical Requirements:

1. Power supply to the unit shall be 3-ph, 50Hz, 400V. If needed, Sarma Afarin also can meet owner's requirement.

2. Contractor shall supply and install the electrical power line and all auxiliary electrical protection devices per local code requirements and as indicated necessary by the chiller manufacturer.

3. Contractor shall supply and install electrical wiring and devices required to interface the chiller controls with the building control system, if applicable.

I. Piping Requirements:

1. Piping and instrumentation for the chilled water, cooling water, flue supply (except for the gas train), and breaching shall be supplied and installed by the contractor/owner.

2. Chilled water flow switch shall be factory supplied and factory installed in the evaporator water nozzle. Condenser water flow switch shall be field installed or factory installed if customer requires and supplied by either the chiller manufacturer or the contractor/owner.

3. Piping from the rupture disk shall be provided and installed by the contractor/owner and piped in accordance with the chiller manufacturer's written instructions.

J. Thermal Insulation:

Insulation of cold or hot surfaces shall be field supplied and field installed on the machine. Chiller manufacturer shall specify the recommended material and surface area to be insulated.

K. Sound Level:

The overall sound pressure level of the chiller shall not exceed 80 dbA when measured at standard of JB/T 4 330.

L. Start-up:

1. Unit manufacturer shall provide a factory-trained service representative, employed by the chiller manufacturer, to perform and/or supervise chiller pressure test (when required), charge chiller with refrigerant (water) and lithium bromide solution, place unit into operation, and calibrate all controls in accordance with the manufacturer's written startup, operating, and maintenance instructions.

2. After unit start-up has been performed, the same factory representative shall be available for a period of instruction (not to exceed 4 hours) to instruct the owner's personnel in the proper start-up, operation, and maintenance procedures.

3. Manufacturer shall provide the following literature:

a. Installation Instructions
b. Star-up, Operating and Maintenance Instructions
c. Field Wiring Diagrams

M. Options and Accessories:

1. High-Pressure Water boxes:

Water boxes rated for 250 psig (1724 kPa) or 300 psig (2068 kPa) working pressure shall be furnished when specified on the equipment schedule

2. Special Tubing:

Tubing of non-standard materials and/or wall thickness shall be provided when specified on the equipment schedule.

3. Dual-Fuel Burner:

A burner capable of operation on either natural gas or No. 2 oil shall be furnished when specified on the equipment schedule.

4. Shipping Configuration:

Chiller shall ship in 1 or 2 pieces, as specified on the equipment schedule.

5. Condenser Water Flow Switch:

A condenser water flow switch, rated for either 150 psig (1034 kPa), 250 psig (1724kPa), or 300 psig (2068 kPa) shall be field installed or factory installed if customer requires and supplied by either the chiller manufacturer or the contractor/owner.