

Expansion Joints for Multi Flue Chimneys in Coal Fired Power Plant

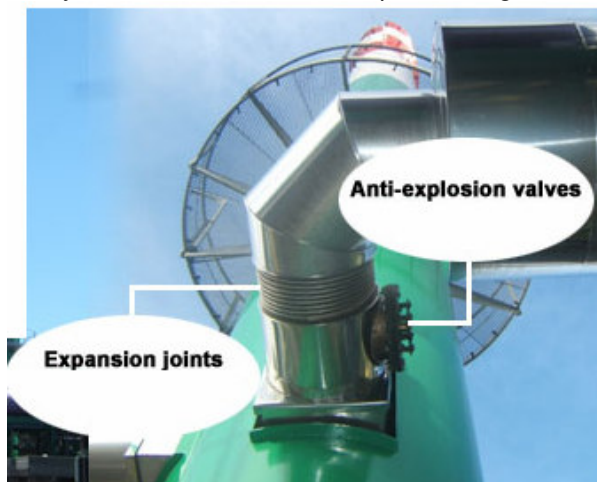
As the need for more Power generation increased, each power station had increased number of plants resulting in optimized utilization of space and resources.

One of the key areas for space optimization was Chimney. Chimney can be defined as a vertical hollow structure of masonry, steel, or reinforced concrete, built to convey gaseous products of combustion from a building or process facility. A chimney should be high enough to furnish adequate draft and to discharge the products of combustion without causing local air pollution. The height and diameter of a chimney determine the draft. For adequate draft, small industrial boilers and home heating systems depend entirely upon the enclosed column of hot gas. In contrast, stacks, which are chimneys for large power plants and process facilities, usually depend upon force-draft fans and induced-draft fans to produce the draft necessary for operation, and the chimney is used only for removal of the flue gas.

When coal, oil, natural gas, wood or any other fuel is combusted in a stove, oven, fireplace, hot water boiler or industrial furnace, the hot combustion product gases that are formed are called flue gases. Those gases are generally exhausted to the ambient outside air through chimneys or industrial flue gas stacks (sometimes referred to as smokestacks).

The combustion flue gases inside the chimneys or stacks are much hotter than the ambient outside air and therefore less dense than the ambient air. That causes the bottom of the vertical column of hot flue gas to have a lower pressure than the pressure at the bottom of a corresponding column of outside air. That higher pressure outside the chimney is the driving force that moves the required combustion air into the combustion zone and also moves the flue gas up and out of the chimney. That movement or flow of combustion air and flue gas is called "natural draught/draft", "natural ventilation", "chimney effect", or "stack effect". The taller the stack, the more draught or draft is created.

Picture of a single flue chimney with the duct from ID fan penetrating the flue is as shown below:



Designing chimneys and stacks to provide the correct amount of natural draught or draft involves a number of design factors, many of which require trial-and-error reiterative methods. One of the key areas for optimization was in Chimney designs – which changed from individual stacks to Multi Flue Chimney.

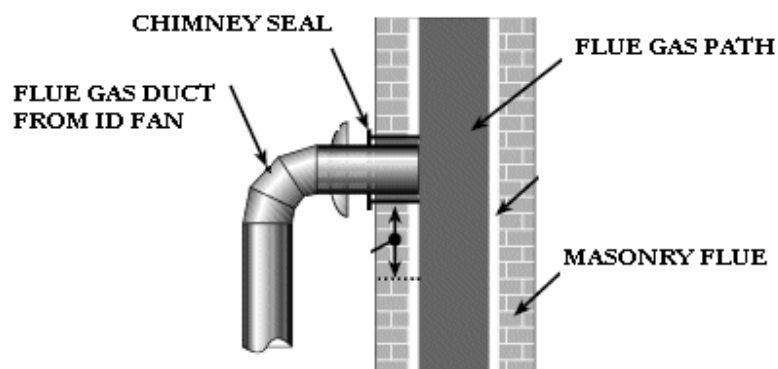
Even in the Multi Flue Chimney – various designs have been employed:

- Brick flue chimney
- Top supported metal flues
- Multi supported metal flues.

Brick Flue Chimney:

In the initial stage of Power Plant development, designers used brick / masonry / concrete flues to minimize the cost. Further, these flues were part of lower capacity boilers which had to discharge less volumes of flue gas which in turn reflected on the draft required and the height of the chimney. Typically in brick flue chimneys, there could be masonry deterioration on the inside or corrosion due to the effect of chemical attack combined with freeze/thaw deterioration.

However, the most significant area of concern for Multi Brick flue chimneys is the area where the flue gas ducting from the ID fan meets with the chimney flue. The typical arrangement would be as illustrated below:

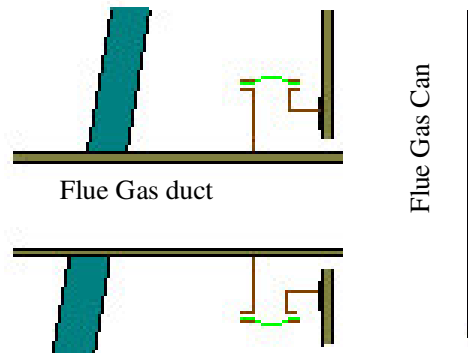


Generally the opening on the chimney flue would be larger compared to the duct size to accommodate the radial expansion of the duct due to thermal expansion and also the possible misalignments. However if this gap is not properly sealed, it could lead to the escape of flue gas along with ash particles. In one of the boiler installations, due to the ash leakage from these gaps the maintenance lift could not be operated.

The following picture shows the progress in construction of a twin flue brick chimney.



KEI has the experience of supplying seals (expansion joints – as these would also compensate the thermal expansions in addition to the sealing activity) for many thermal power stations. The typical arrangement would be as illustrated below:



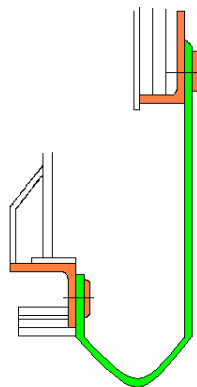
Top supported multi flues:

As the capacity of the boiler increased, necessity for discharging larger volumes of gas increased. To obtain the draft required for handling such large volumes, the chimney height also increased. Annexure "A" gives the height details of some of the tallest chimneys in the world.

View of a top supported multi flue chimney would be as shown below:



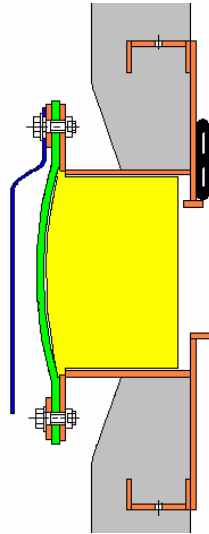
In this case the entire flue can which is supported at the top would experience a very large thermal expansion in the downward direction. If proper arrangement is not provided to compensate this expansion, flue-can would foul with the duct. In addition, the sealing arrangement should also be perfect to prevent leakage of flue gas or fly ash.



In the picture shown above, the green colored material is the seal / expansion joint which would accommodate large thermal movements and at the same time prevent any leakage.

Multi supported Chimney cans:

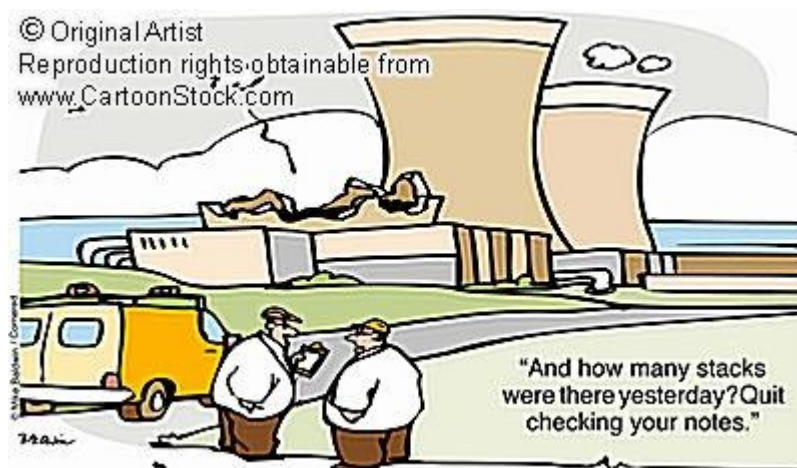
With increased awareness for Global warming and pollution, it has become essential increase the height of expansion joints. Hence with increased height, designers have felt that it is not prudent to continue with top supported flue cans. Hence they have opted for flue can with supports. This would be in line with standard flue gas expansion joints – with special emphasis for possible corrosive external environment in addition to the ash and movements inside the flue cans. Arrangement for these locations would be as indicated below:



Irrespective of the type of chimney installation, KEI has supplied expansion joint for all types of applications. Care must be taken to have the appropriate fabric combination which would take care of

- Thermal expansion
- Temperature and Pressure
- High abrasive fly ash dust
- Possible chemical attack inside the can and externally also

If these are not taken care and a badly designed seal / expansion joint is provided – result would be as shown in the caricature below:



List of tallest Chimneys of the World

Name	Pinnacle height	Country
GRES-2 Power Station	419.7 m	Kazakhstan
Inco Superstack	380 m	Canada
Homer City Generating Station	371 m	USA
Kennecott Smokestack	370.4 m	USA
Mitchell Power Plant	367.6 m	USA
Trbovlje Chimney	360 m	Slovenia
Endesa Termic	356 m	Spain
Phoenix Copper Smelter	351.5 m	Romania
Syrdarya Power Plant	350 m	Uzbekistan
Teruel Power Plant	343 m	Spain
Plomin Power Station	340 m	Croatia
Mountaineer Power Plant	336 m	USA
TETs5	330 m	Ukraine
Zuevskaya GRES	330 m	Ukraine
Ekibastuz GRES-1	330 m	Kazakhstan
2 Chimneys of Kirishskya GRES-1	330 m	Russia
Maritza East Power Station	325 m	Bulgaria
Zaporogskaya GRES	320 m	Ukraine
Mironovskaya GRES	320 m	Ukraine
Rockport Power Plant	316.4 m	USA
Ugljevik Power Plant	310 m	Bosnia
Buschhaus Power Station	307 m	Germany
Harrison Power Station Scrubber	305 m	USA
Robert W Scherer Power Plant	305 m	USA
Independence Power Plant	305 m	USA
Kyger Creek Power Plant	305 m	USA
White Bluff Power Plant	305 m	USA
Harlee Branch Power Plant	305 m	USA
Widows Creek Power Plant	305 m	USA
Hal B. Wansley Power Plant	305 m	USA
Kingston Power Plant	305 m	USA
Harrison Power Station	305 m	USA
Cumberland Power Plant	305 m	USA
W. H. Sammis Power Plant, Unit 7	305 m	USA
Conemaugh Generating Station	305 m	USA
Hayden Smelter	305 m	USA
Plant Bowen Coal	305 m	USA
Chvaletice Power Station	305 m	Czech Republic
Power Plant Scholven	302 m	Germany
Power Plant Chemnitz	302 m	Germany
SASOL Synthetic Fuel Production Plant	301 m	South Africa
Tuřimice Power Station	300 m	Czech Republic
Rybnik Power Station	300 m	Poland

Name	Pinnacle height	Country
Novaky Power Plant	300 m	Slovakia
Clifty Creek Power Plant	300 m	USA
Power Plant Jänschwalde	300 m	Germany
Duvha Power Station	300 m	South Africa
Provence Power Station	300 m	France
Walsum Power Station	300 m	Germany
Herne Power Station	300 m	Germany
Orot Rabin	300 m	Israel
Pruněřov Power Station	300 m	Czech Republic
Chimneys of Boxberg Power Station	300 m	Germany
Jaworzno Power Station	300 m	Poland
Bełchatów Power Station	300 m	Poland
Kozienice Power Station	300 m	Poland
Warszawa-Kawcyn Power Station	300 m	Poland
Bruce Mansfield Power Plant, Unit 1 + 2	289.6 m	USA
Bergkamen Power Station	282 m	Germany
Werdohl-Elveringsen Power Station	282 m	Germany
Fundidora Mexicana de Cobre	280 m	Mexico
John E Amos Power Plant	275.4 m	USA
Dahanu Power Station	275.3 m	India
Ibbenbüren Power Station	275 m	Germany
Chimneys of Kendal Power Station	275 m	South Africa
Chimneys of Lethabo Power Station	275 m	South Africa
Chimneys of Tutuka Power Station	275 m	South Africa
Chimneys of Matla Power Station	275 m	South Africa
Orhaneli Power Plant	275 m	Turkey
Killen Generating Station	274.5 m	USA
Kammer Power Plant	274.5 m	USA
Power Plant Łódź	274 m	Poland
Cardinal Power Plant, Unit 3	272.8 m	USA
MIM Smelter (MIM Smelter Stack)	270 m	Australia
Mělník Power Station	270 m	Czech Republic
Ashbridges Bay Sewage Treatment Plant	261.2 m	Canada
Power Plant Siersza	260 m	Poland
Power Plant Kraków-Leg	260 m	Poland
Power Plant Rybnik	260 m	Poland
Chimneys of Loy Yang	260 m	Australia
Shawville Generating Station	259 m	USA
R E Burger Power Plant	259 m	USA
Drax Power Station	259 m	UK
Chimneys of W. H. Sammis Power Plant, Unit 5 + 6	259 m	USA
Dětmorovice Power Station	259 m	Czech Republic
Loy Yang	255 m	Australia
Gen. J. M. Gavin Power Plant	253 m	USA
Chimneys of Yates Power Plant	253 m	USA

Name	Pinnacle height	Country
Power Plant Moszna	253 m	Poland
El Paso Smelter	252.5 m	USA
Power Plant Polaniac	250 m	Poland
Chimneys of Majuba Power Station	250 m	South Africa
Chimney 1 and Chimney 2 of Orot Rabin	250 m	Israel
Chimneys of Matimba Power Station	250 m	South Africa
Chimneys of Porto Tolle Power Station	250 m	Italy
AES Tisza 2 Power Plant	250 m	Hungary
Chimneys of Elektrenai Power Plant	250 m	Lithuania
Chimneys of Bayswater Power Station	250 m	Australia
Mount Piper Chimney	250 m	Australia
Chimneys of Taichung Power Plant	250 m	Taiwan
Chimneys of Vilnius 3 Power Plant	250 m	Lithuania
Power Plant Katowice	250 m	Poland
Power Plant Opole	250 m	Poland
artificial fibre factory "WISKORD"	250 m	Poland
Voerde Power Station	250 m	Germany
Chimney Grosskrotzenburg Power Station	250 m	Germany
Chimney Lünen Power Station	250 m	Germany
Unit 6 of Bremen-Hafen Power Station	250 m	Germany
Altbach Power Station	250 m	Germany
Heilbronn Power Station	250 m	Germany
Wilhelmshaven Power Station	250 m	Germany
Chimneys Duisburg-Schwegern	250 m	Germany
Chimney Duisburg-Neuenkamp	250 m	Germany
Chimney Duisburg-Hochfeld	250 m	Germany
Mehrum Power Station	250 m	Germany
ASARCO Cooper Plant	248 m	USA
Yates Power Plant	245.4 m	USA
Monroe Power Plant	244.1 m	USA
Shawnee Power Plant	244 m	USA
Grain Power Station	244 m	UK
Chimneys of Miami Fort Power Plant	244 m	USA
Chimneys of J M Stuart Generating Station	244 m	USA
Chimneys of Homer City Generating Station, Unit 1 + 2	244 m	USA
Paradise Power Plant	244 m	USA
Chimneys of Keystone Generating Station, Unit 1 + 2	244 m	USA
Bull Run Power Plant	244 m	USA
Associated Electric Stack #1	243.8 m	USA
Marl-Chemiepark Power Station	241 m	Germany
Scholven A Power Station	240.5 m	Germany
Voerde Power Station	240 m	Germany
Chimneys of Bexbach Power Station	240 m	Germany
Cuno Power Station	240 m	Germany
Chimneys of Luohuang Power Station	240 m	China
Allen S King Generating Station	239.5 m	USA
Chimneys of Navajo Generating Station	236.2 m	USA

Name	Pinnacle height	Country
Chimney Inverkip Power Station	236 m	UK
Chimneys of Niederaussem Power Station	234 m	Germany
Chimney Heating Power Station Karlsruhe	233 m	Germany
Chimneys Weiher Power Station	232 m	Germany
Voerde Power Station	230 m	Germany
Callide 'C' Power Station	230 m	Australia
Power Plant Lubin	230 m	Poland
Castrop-Rauxel Power Station	230 m	Germany
New Castle Power Plant	228.6 m	USA
Heyden Power Station	227 m	Germany
Power Plant Bielsko Biala	225 m	Poland
Power Plant Kraków-Leg	225 m	Poland
Moneypoint Generating Station	225 m	Ireland
Heating Power Station Gera-Nord	225 m	Germany
Chimney Power Station Jena	225 m	Germany
Chimney Power Station Asnæsværket	220.1 m	Denmark
Chimneys of Bayer-Power Station Leverkusen	220 m	Germany
Schilling Power Station	220 m	Germany
Power Plant Glogow	220 m	Poland
Power Plant Polkowice	220 m	Poland
Power Plant Toruń	220 m	Poland
Chita Power Plant Units 1-4	220 m	Japan
Mittal Steel Ostrava	220 m	Czech Republic
Počerady Power Station	220 m	Czech Republic
West Power Station	218 m	Germany
Pembroke Power Station Chimney	217.3 m	UK
Shell Pernis	216 m	Netherlands
the Hongkong Electric Lamma Island Power Plant	215 m	Hong Kong
Littlebrook Power Station , Unit 'D'	215 m	UK
Richard L. Hearn Thermal Generating Station	214.9 m	Canada
Iatan Power Plant	213.5 m	USA
Oswego Generating Station	213.5 m	USA
Matla Power Station	213.5 m	South Africa
Nebraska City Power Station	213.5 m	USA
Chimneys of Lacygne Power Plant	213.5 m	Kazakhstan
Oswego Generating Station, Unit 5	213.5 m	USA
Rush Island Power Station	213.5 m	Ireland
Chimneys of Labadie Power Station	213.5 m	USA
Chimneys of Morgantown Power Plant	213.5 m	USA
Alma Power Station	213.5 m	USA
Sibley Generating Station	213.3 m	USA
Power Plant Kielce	213 m	Poland
Guangdong Yudean Jinghai Power Generation Station	210 m	China
Guangdong Red Bay Generation Powerplant	210 m	China
Zhanjiang Aoliyou Powerplant	210 m	China
Tarong North Power Station	210 m	Australia

Name	Pinnacle height	Country
Huaneng Shantou Powerplant	210 m	China
Stanwell Power Station	210 m	Australia
Callide Power Station, Unit 'B'	210 m	Australia
Tarong Power Station	210 m	Australia
Chimney Power Station Moers-Meerbeck	210 m	Germany
Chimney Power Station Dortmund-Derne	210 m	Germany
Chimney Karlsruhe	210 m	Germany
Gustav Knepper Power Station	210 m	Germany
Chimneys of Poolbeg Generating Station	207.3 m	Ireland
Ironbridge Power Station	205 m	UK
Zinifex Smelter (Zinifex Smelter Stack)	205 m	Australia
Fina Antwerp Olefins Flare	205 m	Belgium
Slovalco	204 m	Slovakia
Mondi Business Paper SCP	204 m	Slovakia
Cooling tower of Niederaussem Power Station	200 m	Germany
Power Plant Katowice	200 m	Poland
Power Plant Zabrze	200 m	Poland
Power Station Kozienice	200 m	Poland
Power Plant Bedsin-Lagisza	200 m	Poland
Power Station Patnow	200 m	Poland
Power Station Poznań-Karolin	200 m	Poland
Power Station Warszawa-Siekierki	200 m	Poland
Power Station Gdańsk	200 m	Poland
Power Station Warszawa-Zeran	200 m	Poland
Chimney Power Station Mannheim-Neckarau	200 m	Germany
Chimney Ludwigshafen	200 m	Germany
Chimney Leverkusen	200 m	Germany
Chimney Essen-Karnap	200 m	Germany
Chimney Power Station Hamm-Schmehausen	200 m	Germany
Chimneys of Frimmersdorf Power Station	200 m	Germany
Hekinan Power Plant, Units 1-3	200 m	Japan
Chimneys of Eraring Power Station	200 m	Australia
Simmering Power Station, Unit 3	200 m	Austria
Sant Adria de Besos Power Station	200 m	Spain
Fiddler's Ferry Power Station	200 m	UK
Sakaide Power Plant, Units 2-4	200 m	Japan
Anan Power Plant	200 m	Japan
Atsumi Power Plant	200 m	Japan
Chita Daini Power Plant	200 m	Japan
Chita Power Plant	200 m	Japan
Irsching Power Station	200 m	Germany
Stadtwerketurm	200 m	Germany
Chimney Breitung	200 m	Germany
Chimneys Wilhelmshaven	200 m	Germany
Schkopau Power Station	200 m	Germany
Schwedt Power Station	200 m	Germany
New Plymouth Power Station	200 m	New Zealand

Name	Pinnacle height	Country
Cementárna Maloměřice	200 m	Czech Republic
Škoda Auto	200 m	Czech Republic
Mělník Power Station	200 m	Czech Republic
Ledvice Power Station	200 m	Czech Republic
Počerady Power Station	200 m	Czech Republic
Spolana Neratovice	200 m	Czech Republic
Gibson Generating Station	199.7 m	USA
Gibson Generating Station	195.6 m	USA
Tepláreň	185 m	Slovakia
Anaconda Smelter Stack	178.3 m	USA
Petrochema	160 m	Slovakia
Volkswagen	150 m	Slovakia
Novaky Power Plant-B, Units 1 + 2	150 m	Slovakia
Dům Děti a Mládeže v Modřanech	15 m	Czech Republic
Halsbrücker Esse	140 m	Germany