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Guideline for Technical Regulation Volume 2

Design of Thermal Power Facilities

Book 4/12

« Coal Fuel Handling Facility »

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List of Acronyms/Abbreviations

ASME	American Society of Mechanical Engineers
ASTM	American Society for Testing and Materials
DEM	Dust Extinction Moisture
DGS	(unknown)
DWT	Dead Weight Tonnage
GS	(unknown)
ISO	International Organization for Standardization
JIS	Japanese Industrial Standard
KVM	Krypton Vertical Mill
LEL	Lower Explosion Limit
NETI	Ministry of Economy, Trade and Industry
MPS	(unknown)
MRS	Mitsubishi Rotary Separator
NFPA	National Fire Protection Association
TENPS	Thermal and Nuclear Engineering Society of Japan
OSHA	Occupational Safety and Health Act
UEL	Upper Explosion Limit
VS	(unknown)

Chapter-1. Comparison between Technical Regulation and Technical Guideline of coal fuel handling facility

The article number of this guideline is shown in the Table-1 contrasted technical regulation with technical guideline for easy understanding.

Table- 1: Comparison between Technical Regulation and Technical Guideline of coal fuel handling facility

Technical Regulation		Technical Guideline	
Article 43.	General provision of coal unloading facility	Article 43.	General provision of coal unloading facility
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		-1-4.	Continuous unloader
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-3.	Electrical equipment for vehicle		
-4.	Other requirement for vehicle		

Technical Regulation		Technical Guideline	
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-1.	Requirement for vehicle type mining machine	-1.	Requirement for vehicle type mining machine
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-1.	Spontaneous combustion	-1.	Spontaneous combustion
-2.	Measure for coal dust	-2.	Measure for coal dust
-3.	Measure for rain water	-3.	Measure for rainwater
-4.	Stock capacity	-4.	Angle of repose
-5.	Requirement	-5-1.	Requirement for coal storage yard
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		-5-3.	Stacker and reclaimer
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Article 52.	Indoor coal storage yard and coal storage silo	Article 52.	Indoor coal storage yard and coal storage silo
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-2.	Coal dust explosion	-2.	Coal dust explosion
-3.	Gas explosion	-3.	Gas explosion
	General	-4-1.	General of indoor coal storage yard
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		-4-3.	Dome type storage yard
		-4-4.	Silo type storage yard
Article 53.	Coal discharge facility	Article 53.	Coal discharge facility
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Article 55.	General provision of coal dressing facility	Article 55.	General provision of coal dressing facility
-1.	General	-1-1.	Overview of PC combustion facility
		-1-2.	System for direct combustion
Article 56.	Coal bunker	Article 56.	Coal bunker
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-2.	Measure to prevent blockage	-2.	Angle and liner of coal bunker
-3.	General	-3-1	Thermometer for bunker
Article 57.	Coal feeder	Article 57.	Coal feeder
-1.	Requirement	-1-1.	Coal feeder
Article 58.	Coal pulverizer	Article 58.	Coal pulverizer
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		-1-4.	Crusher
		-1-5.	PC bin system

Article 43. General provision of coal unloading facility

Article 43-1-1. Nature of coal

1. Coal reserves are largest amount among energy resources and were the main fuel for thermal power generation in the early boilers. However, main fuel has been shifted from coal to crude oil and heavy oil due to the increasing demand of energy. However in Japan, coal is reviewed again after the oil crisis and cheaper imported coal from Australia, Canada and China has been used, along with the closure of domestic mines.
2. Classification of coal

   There are various classifications of coal such as the geological classification (land planted coal, residual coal, peat such as corrosion due to the origin of coal), particle size classification (lump charcoal, dust coal, fine coal, grain size on the cleaning of coal by pulverized coal, etc.), classification by purpose (for general use, for raw material or for gas production). The classification by degree of carbonization (by the progress of hydrocarbons such as peat, lignite, bituminous coal, anthracite) as shown in Table-2 is generally used.

Table- 2: Classification of coal

(1) Peat	It is known as the plant coal. It is the low-grade coal which carbonization has not moved forward because plants were immersed in the water without contacting the air. The vegetable matters have been buried deep underground in long age and decomposited to a brown or black. It contains plenty of moisture (60~90%) and has low calorific value. It is used as fuel and fertilizer for household after dehydration and drying.
(2) Brown coal or lignite	Coal carbonization degree advanced from peat, which contains about 15~70% of moisture as well as peat. The calorific value is higher than peat, lower when compared with bituminous coal. The low degree of carbonization lignite (brown brown coal or brown lignite) is called as sub-lignite and may be distinguished from brown coal. It is used for general fuel and may be used as boiler fuel.
(3) Bituminous coal	It is the coal with black or dark black colors and usually used as boiler fuel. It has advanced degree of carbonization, has less moisture and high calorific value. The ratio between fixed carbon and volatile matter (this is called “fuel ratio”) can be divided into sub-bituminous coal and bituminous coal in the narrow sense, or high-grade bituminous and low-grade bituminous.
(4) Anthracite	Those of the most advanced degree of carbonization of coal, low volatile matter, most of the carbon content, high calorific value. It is necessary to consider the combustion system and structure of boiler furnace when using as boiler fuel, since it is hard to burn it due to less volatile.

Reference: P-41 of Journal (No.588: Sept. /2005): TENPES

Table- 3: Calculation of coal reserves (JIS M1002-2006)

Classification		Higher Heating Value (corrected no-moisture, no-ash base) kJ/kg (kcal/kg)	Fuel ratio	Caking property
Coal quality	class			
Anthracite (A)	A1	—	4.0 and more	Non-caking
	A1			
Bituminous coal (B, C)	B1	H ≥ 35,160 (h ≥ 8,400)	1.5 and more	Strong caking
	B2		Less than 1.5	
	C	35,160 > H ≥ 33,910 (8,400 > h ≥ 8,100)	—	Caking
Sub-bituminous coal (D, E)	D	33,910 > H ≥ 32,650 (8,100 > h ≥ 7,800)	—	Slightly caking
	E	32,650 > H ≥ 30,560 (7,800 > h≥ 7,300)	—	Non-caking
Broun coal (F)	F1	30,560 > H ≥ 29,470 (7,300 > h ≥ 6,800)	—	Non-caking
	F2	29,470 > H ≥ 24,289 (6,800 > h ≥ 5,800)	—	

Note: Calorific value (corrected no-moisture, no-ash base) = calorific value/ (100-ash correction factor × ash content-moisture content)

However, the correction factor of coal ash is based on the system of coal distribution public corporation.

Table-3 shows the approximate relationship between the fuel ration and the calorific value. As the classification of coal, coal may be called by the name of coal mine, for example, Orchard Valley (USA), Orbed (Canada), Lithgow (Australia), Briar Athol 8Australia), Tatung (China), Ombilin (Indonesia), says that “coal bland”.

3. Nature of coal

The nature of coal can be known by such industry analysis, ultimate analysis, calorific value, coking properties, ash property as shown in Table-4. The industrial analysis is the most basic matter in knowing the coal quality and determines how to burn coal, which coal was classified into moisture, ash, volatile matter and fixed carbon. Analysis and testing method are defined by JIS M8812.

Table- 4: Nature of coal

(1) Moisture	Moisture is consisting of Surface Moisture (attached on the surface of coal) and Inherent Moisture (absorbed in the coal). Inherent moisture is expressed as a percent of the same sample weight loss when heated and dried for 1 hour at 107 ^{o}C. The inherent moisture is typically 3% or less in case of bituminous coal.
(2) Ash	Ash is the inorganic mineral contained coal and the remaining residue after coal firing. The residue which organic matters burned when the sample was heated to 750^{o}C in the vessel is expressed in weight percent.
(3) Volatile matter	Volatile matter is hydrogen, carbon monoxide, methane, phenol, pitch and various hydrocarbons, which above mentioned moisture content% is reduced the remaining weight% after heating sample for 7 minutes at 95^{o}C.
(4) Fixed carbon	Fixed carbon was reduced moisture%, volatile matter% and ash% remaining in the residue from 100% by heating or combustion the above, and can be considered as a single carbon. As described in the previous section, this is an important characteristic for determining the value and combustion characteristics by knowing the nature of coal, which the ratio between fixed carbon and volatile matters.

Reference: P-42 of Journal (No.588: Sept. /2005): TENPES

In addition to the industrial analysis, sulfur content, calorific value, grindability (Hardgrove Index), coking property, analysis of combustion (Burning Profiles), Ultimate analysis are required to know the nature of coal. Coal is a kind of polymer with a complex carbon compounds and have different chemical components in the coal even by the same origin. Table-5 shows an example of industry analysis and ultimate analysis of the foreign coal.

Table- 5: Example of coal composition

Country	Bland	Higher heating value	Moisture content (3)	Industrial analysis (1)				Fuel Ratio	Ultimate analysis (2)					
				Moisture content	Ash content	Volatile matter	Fixed carbon		C	H	N	O	S	All S
		(MJ/kg)	(%)	(%)	(%)	(%)	(%)		(%)	(%)	(%)	(%)	(%)	(%)
Australia	Drayton	28.4	3.4	3.4	13.3	34.5	48.8	1.4	71.1	4.9	1.4	8.1	0.8	0.9
	Newlands	28.0	3.0	3.0	15.0	26.6	55.4	2.1	69.1	4.1	1.4	7.0	0.4	0.4
	Huntervalley	29.6	3.5	3.5	11.2	34.0	51.3	1.5	72.7	4.5	1.6	9.3	0.3	0.6
	Lemington	28.4	3.7	3.7	13.0	32.3	51.0	1.6	71.9	4.6	1.5	8.2	0.4	0.4
	Workworth	28.9	3.6	3.6	11.8	321.8	51.8	1.6	69.1	4.5	1.5	8.9	0.4	0.4
China	Tatung	29.6	10.1	5.1	7.0	28.1	59.8	2.1	78.2	4.5	0.8	8.8	0.6	0.7
	Nantun	28.4	8.0	4.0	16.0	36.2	43.8	1.2	83.0	5.2	1.6	9.8	0.5	0.8
Canada	Obed	25.3	8.0	5.0	14.0	37.0	44.0	1.2	64.3	4.6	1.5	14.3	0.3	0.6
	Coal Valley	26.1	11.3	6.4	10.7	33.5	49.3	1.5	69.7	4.7	0.9	13.1	0.1	0.3
Indonesia	Satui	28.8	9.5	5.1	7.9	41.9	45.1	1.1	72.4	5.5	1.2	11.9	0.7	0.8
South Africa	Ermelo	27.8	7.6	3.5	12.9	31.4	52.2	1.7	72.0	4.4	1.7	7.9	0.6	0.8
	Optimum	28.5	8.2	3.8	10.7	32.4	53.1	1.6	72.9	4.9	1.6	9.1	0.5	0.6
USA	Pinnacle	27.2	8.3	4.6	13.4	40.9	41.1	1.0	68.2	5.6	1.4	0.3	0.6	0.7
	Plateau	25.1	9.8	6.0	9.3	41.8	42.9	1.0	72.8	5.5	1.5	11.2	0.7	0.9

Note(1): as received basis Note(2): air dried basis Note(3): moisture free basis

Reference: P-42 of Journal (No.588: Sept. /2005): TENPES

4. Type of coal transportation

Vietnam is the coal producing country and the anthracite dust coal, bituminous coal, sub-bituminous coal or dust coal which is produced in northern Vietnam is used as the fuel for the thermal power plant located inland. Transportation of domestic coal is performed by the conveyor, railway, vehicle and domestic vessel. However, due to soaring electricity demand, the large-scale power plants located in coastal areas will be necessary to import foreign coal.

Therefore, following transportation methods might be applied.

1) Coal would be transported mainly by conveyors for coal fired power plant located adjacent to the coal field area.
2) Coal would be transported by railway or vehicle or domestic vessel for coal fired power plant located inland.
3) Coal would be transported by large ocean vessel for coal fired power plant located in coastal area.
4) Coal would be imported to the coastal coal center and distributed to power plants located inland by domestic vessel or railway or vehicle.

Article 43-1-2. System of coal transportation

The flow of coal is organized in Fig-1 taking into account the future development of Vietnam, a combination of types of transportation and handling methods which will be applied in practice.

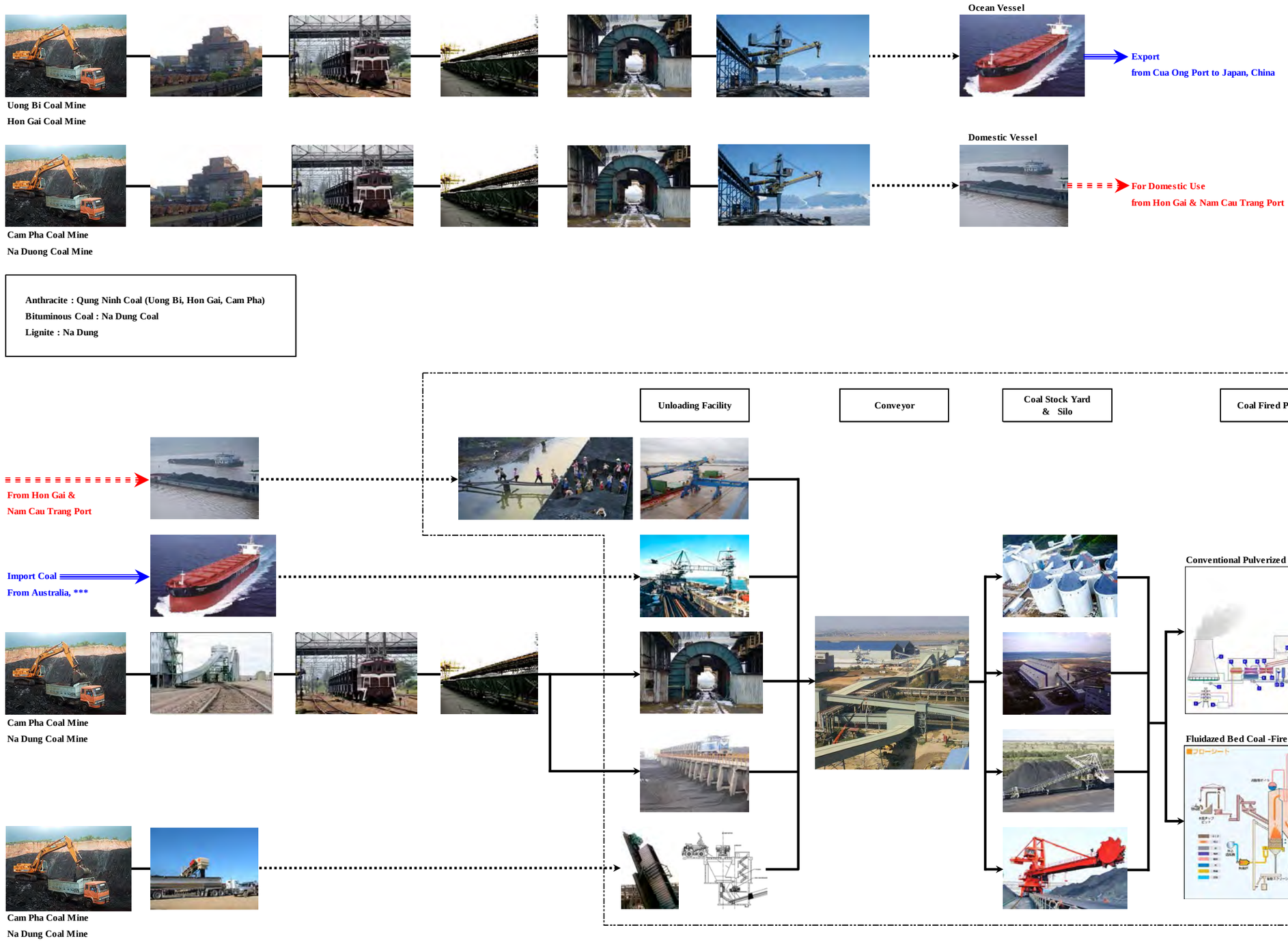


Fig- 1: Constitution concept of fuel handling facilities for coal thermal power plant

Article 43-1-3. Outline of coal handling facility

1. The coal receiving equipment is different in the case of land transportation and in the marine transportation. In the past, the land transportation was the main; however, marine transportation will become necessary with increasing use of coal and foreign large-capacity facilities. In case of the transportation by coal wagon, coal unloading is performed by mean of providing railway in the power plant premise and guides the side-open or bottom-open wagons onto receiving hoppers. In addition, the car-dumper is sometimes applied to open the coal wagons. The car-dumper is an equipment to release contents by tilting the wagon. In either case, coal is transported from hopper to coal yard by belt conveyor.

   It is necessary to improve berthing quay deep enough and capable of coal handling in case of transportation by vessel. The 1,000~20,000DWT class vessel is used for the domestic coal carrier, the at least 35,000DWT class vessel is used for the ocern-going vessels and recently 150,000DWT class vessel is used for the ocern-going vessels. Unloading is performed by the unloader with capacity 50~3,000t/h mounted on quay. Also, self-unloader ship which has unloading function has been used. The hoist to unload coal is called “unloader”. Unloaders are divided into two types such as grab bucket intermittent type and continuous type. The grab bucket type has horizontal refractive type, gantry type and tower type. The continuous type has bucket elevator type, bucket wheel type and vertical screw conveyor type.

Article 44. Warf facilities

Article 44-1-1. Berthing quay

1. The foreign coal is transported from the coal field area by large ocean-going bulk carrier. The private quay is provided in the premise or adjacent power plant as shown in Photo-2 for safe mooring during bad weather and stability during coal unloading. In addition, if the sea or river shore of power plant is shallow, Quay itself is provided in the place to meet the draft of ocean vessels as shown in Photo-1 and 2.

Photo- 1: Private coal unloading quay (1)

http://118.23.181.81/imgs/kaiyou/i_141_2270.jpg

Photo- 2: Private coal unloading quay (2)

http://www.kajima.co.jp/project/works/ex/image/reihoku-hatsuden.jpg

Article 44-1-2. Mooring facility

1. The robust moorings depending on the size of vessels as shown in Photo-3, 4 are essential in order to prevent the movement of ship, to prevent damage to the quay and ship and perform unloading work safely, since coal is unloaded by dedicated unloader in case of large ocean vessel.

Photo- 3: Mooring buoy (1)

http://www.mgb.gr.jp/gohda/ocean/images/moor1_2.jpg

Photo- 4: Mooring buoy (2)

http://opi-rina.chunichi.co.jp/yumi/images/100611_153822.jpg

Article 44-1-3. Fender equipment

1. The fender equipments depending on the size of vessels as shown in Photo-5, 6 are essential as well as mooring buoys in order to prevent the movement of ship, to prevent damage to the quay and ship and perform unloading work safely, since coal is unloaded by dedicated unloader in case of large ocean vessel.

Photo- 5: Fender on quay (1)

http://www.sbt.co.jp/topics/2011/0902/02.jpg

Photo- 6: Fender on quay (2)

http://www.civil-works-sri.com/marine/pi/img/pic01.jpg

Article 44-2-1. Bollard equipment

1. The bollards such as Photo-7, 8 are required in order to prevent worker or vehicle falling into the sea and to prevent pollution due to dropped coal by unloading work on the quay and rainwater when berthing the large ocean vessel.

Photo- 7: Bollard on quay (1)

http://www.pa.ktr.mlit.go.jp/yokohamagicho/06_koho/nagisa2/images/tokusyu-images/tokusyu1-image2.jpg

Photo- 8: Bollard on quay (2)

http://www.chudai.co.jp/harbor/images/harbor02.jpg

Article 44-2-2. Truck hopper

1. Incase of medium or small carriers, coal is often unloading to quay by own bucket crane or unloading by bucket crane installed on quay. In this case, The hopper as shown in Photo-9, 11, 12 are installed on the quay temporary, unload into them and transport to coal yard by vehicles intermittently in order for environmental protection to avoid such situation as shown in Photo-10. This can be moved the truck hopper after work, and often used in shared quay instead private quay.

Photo- 9: Truck hopper (1)

http://www.inate2.com/images/work1pno1.jpg

Photo- 10: Direct unloading on the quay

http://www2.ezbbs.net/22/zyari/img/1148957477_1.jpg

Photo- 11: Truck hopper (2)

http://stock.sancsoft.net/images/MobileHopperTruck3.jpg

Photo- 12: Truck hopper (3)

http://www.contrafedpublishing.co.nz/site/contrafed/images/2009/Mining/Toys_2.jpg

Article 45. Unloader and bucket crane

Article 45-1-1. Type of unloader

1. The unloader may be provided on quay in order to unload coal from carrier, it usually moves along the quay. Generally, 2~4 unloaders are provided on quay and are used for common unloading work at the same time. The horizontal retractable type and gantry type is used for the grub bucket type; the bucket elevator type is mainly used for continuous type. The horizontal retractable type is suitable for 10,000~20,000DWT class bulk carrier, the gantry type and the continuous type are suitable for the large unloader unloading from large private vessels.

   The continuous type has high handling efficiency and is capable to operate easily with less dust by enclosed conveyor line. Therefore, the dedicated line with type of unloading of large vessels in recent years has become from "horizontal retractable type" to "gantry type" to "continuous type" and tends to increase its capacity. The gantry type and continuous type become more advantageous above the border of normal capacity around 600t/h of the ability of one single unloader and the horizontal retractable type become more advantageous below the border of normal capacity around 600t/h from the technical and economical viewpoint. It is considered the limit of gantry type is 3,000t/h and continuous type is 4,000t/h from technical and economical viewpoint.

Article 45-1-2. Horizontal retractable type unloader

1. The jib crane type unloader as shown in Photo-13, 14 which jib crane is mounted on gantry structure, can be moved and carry luggage in back and froth motion horizontally. It can be extremely small turning radius and can move freely in confined area by means of pulling the tip of the jib in place prior to turning. Moreover, it is easy to transfer into the hold of the bucket and fewer frequency of moving during the entire unloading operation, it can be change hatch quickly compared with gantry type.

Photo- 13: Double link type unloader (1)

http://www.ubemachinery.co.jp/seihin/b_hand/image/unloader_1.jpg

Photo- 14: Double link type unloader (2)

http://www.showa-crane.co.jp/images/crane_jisseki/crane013.jpg

Article 45-1-3. Gantry type unloader

1. This is the unloader as shown in Photo-15, 16 and Fig-2 with the bucket as shown in Photo-17 which run on rails laid on the ground and trolley move with bucket. One or both ends of the girder which is protruded to the outside of leg, it can advance to the outside of the rail of traveling trolley, the center of the ship working range is extended to it further. And there are many possible structures folding up, down and turning angle protruded girder.

Photo- 15: Gantry type unloader (1)

http://www.ubemachinery.co.jp/seihin/b_hand/image/unloader.jpg

Photo- 16: Gantry type unloader (2)

http://www.mhi.co.jp/products/expand/__icsFiles/artimage/2009/07/30/cj_pd_hw_ex/rope_trolley_unloader.JPG

Photo- 17: Clamshell grab bucket

http://img.tootoo.com/mytootoo/upload/54/547627/product/547627_81a012a9a57e354f2b2c989ca8b82589.jpg

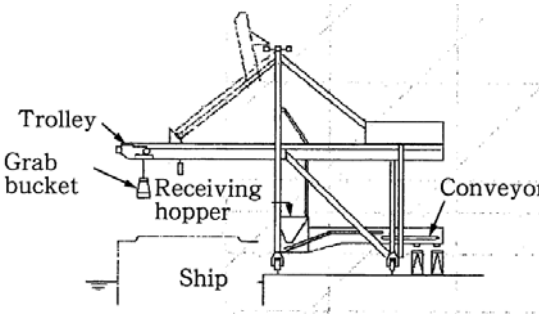


Fig- 2: Grab bucket type unloader

Reference: P-150 of Handbook for thermal power facility Ver.7 2008: TENPES

Article 45-1-4. Continuous unloader

1. The bucket elevator type which many buckets are provided on the loop chain supported by the tip of boom as shown in Photo-20 and the rotary bucket is provided rotary bucket combined with boom conveyor as shown in Photo-21 is an example of continuous unloader. They unload coal from the hold by means of traveling, transversing, boom pivoting and bucket elevator pivoting. It can be lifted cargo in the back part from hatch of the hold by pivoting elevator to suit the hold. It can be almost automatic operation, since each operation is simple. It is capable to keep reduce equipment cost, since the capacity of receiving conveyor will be less according to the high efficiency of continuous

loading, although power consumption is larger than other facility. In addition, the It is capable to enclose the bucket elevator part and conveyor part except drilling part in the hold and is excellent for dust prevention. The bucket elevator type unloader is shown in Photo-18 and the bucket wheel type unloader is shown in Photo-19.

Photo- 18: Bucket type continuous unloader

http://www.jacms.or.jp/niyakukikai/images/newwin/unloader_02.jpg

Photo- 19: Wheel type continuous unloader

http://www.hakodate-dock.co.jp/jp/04_bridge_machinery/img/imgb09.jpg

Photo- 20: Bucket type elevator

http://blogs.yahoo.co.jp/onchikappa/27390483.html

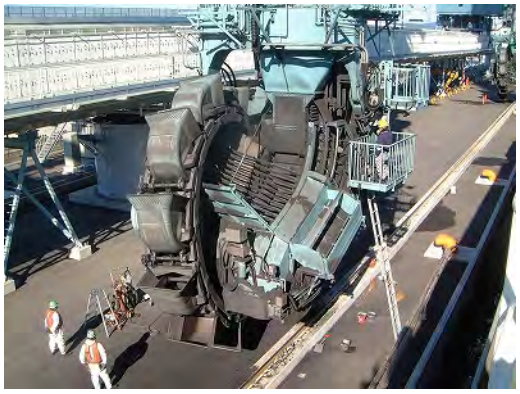


Photo- 21: Bucket wheel

http://blogs.yahoo.co.jp/onchikappa/27390483.html

Article 45-1-5. Bucket crane

1. The grab bucket crane is often used in the power plant which has only general purpose quay without space for installation of dedicated unloader. The crane itself as shown in Photo-22 which is provided on the ship and Photo-23 which is provided on the land are available. However, this has the disadvantage that the quay is contaminated when coal is scattered directly on the quay without hopper.

Photo- 22: Bucket crane (1)

http://blog-imgs-27-origin.fc2.com/n/a/i/naisuiro/FI2617786_3E.jpg

Photo- 23: Bucket crane (2)

http://www.yomiuri.co.jp/feature/20110316-866918/news/20110520-OYT1T00475.htm

Article 45-1-6. Ship loader

1. Some power plant may distribute imported coal to other power plant after receiving it; however, it is not necessary to provide shiploader except in the key power plant which has the coal center function. It is preferable to provide the dedicated shiploader as shown in Photo-24, 25 in order to perform a quick loading to domestic vessels in the power plant assuming the distribution.

Photo- 24: Coal shiploader (mobile) (1)

http://www.ameco-tm.com/wp-content/uploads/IMG_1970

Photo- 25: Coal shiploader (mobile) (2)

http://www.mayerinternational.com/case-studies.php

Article 45-2. Requirement for continuous unloader

1. The unloader is the cargo handling equipment to unload bulk cargo such as iron ore, grain coal and bauxite from the hold of carrier. These are generally placed in the private sector and can not quite be seen. Also, type varies depending on the handling materials and capacity (handling weight per hour: t/h) and there are historical courses.

   The continuous unloader is mainly used in the coal-fired power plant and steel mill plant. The intermittent handling by grab bucket had previously been applied, and replaced with the continuous unloader in the aspect of the efficiency and environmental measures. The main structures are consisting of the hold scraping bucket elevator, the boom supporting it, the pivoting frame to pivot boom, etc and the portal frame to support the whole.

   Scraped raw materials such as the swept coal are fed to bucket elevator to boom conveyor, which is

transferred to the flight conveyor in the portal frames to the ground convertor. The unloader is placed on the rail on the ground and the other is the ship. The scraping height of cargo changes depending on the tide, loading status. The boom has become possible to roll in order to enable to handle in all ranges. In addition, the hydraulic shock absorber device which is called floating equipment is provided so that no collision damage of scraper due to a sudden swelling of ship bottom. The machinery and equipment may be damaged, because foreign matter is mixed in handling material. The magnetic separator and foreign material remover are provided in order to remove these.

There is a hydraulic drive and electric drive for scraping, etc. and the appropriate system have been addressed in the optimal case by case basis. There is an efficiency to unload a ship as the important indicator of the unloader. That efficiency of continuous unlosder is 80% and more whereas it was approximately 60% in a conventional grab type unloader, it means that it can be unloaded from ship in a short time. It is enough to save a few million dollars a year of demurrage. There is no dust scattering and falling to the sea as unloading by grab bucket type, since the flow of cargo also substantially sealed. It can be increased handling capacity compared with its weigh; the world' largest unloaders with capacity about 3,000t/h for coal and 4,000t/h for iron ore have been supplied.

Article 45-3. Requirement for intermittent unloader

1. The bucket crane is a mobile crane itself and the construction; capacity and safety equipments must be conform to the design standard of crane. The safety operation and capacity is largely depending on the maneuver and skill of driver. When coal dust is scattering, hand watering by an assistant is needed.

Article 46. Locomotive, wagon and track

Article 46-1. Locomotive and orbit

1. **"Withstand the maximum expected load"** stipulated in design Technical Regulation Article46-1-(1)-1) means consisting of rails and sleepers listed in the middle and right column depending on the weight of locomotive in the left column of Table-6.

Table- 6: Standard for sleeper

Weight of the locomotive (t)	Type of rail (Nominal weight(kg))	Sleeper					
		Width (cm)	Thickness (cm)	Length(m)			Max.distance (cm)
				Gauge 508mm	Gauge 610mm	Gauge 762mm	
2 ≤ L	6	9 and more	7 and more	80 or less	90 or less	110 or less	75 or less
2 < L < 5	9						
5 ≤ L < 7	10	12 and more	9 and more				100 or less
7 ≤ L < 10	12						
10 ≤ L < 15	15	15 and more	12 and more				
15 ≤ L	22						

Furthermore, the sleeper may be circle more than 9cm diameter for the locomotive with weight below.

Reference: Section-6 of technical guidrline for technical regulztion of mining facility Japan

2. **"No variation or interference with the safe driving of the vehicles"** stipulated in design Technical Regulation Article46-1-(1)-1) means that the accuracy of track construction conform to the following conditions;

(1) The robust must be fastened by spikes, screw nails on the sleepers and concrete roadbed.
(2) In principle, spikes must be a figure of eight in a given direction.
(3) The gauge must be +5mm and -3mm in case of the block, +7mm and -4mm in other case.
(4) In the strait sections, the top surface of right and left rails must be horizontal and standard deviation must be 10mm or less.
(5) The top surface of rails must not have unevenness in strait section and the unevenness in height must be less than 10mm per 5m.
(6) The orbit must be laid down without deviation and be installed with a deviation less than 10mm per 10m.
(7) In the rail joints, if providing gap considering the stretch of rail due to temperature difference, it must be within 5m and discrepancy between the front and rear sides of the rail must be within 3mm each.

3. **"Shall not interference with the safe running"** stipulated in design Technical Regulation Article46-46-1-(2) means that the radius of curvature of the orbit is 10 times the wheelbase of vehicle passing through such places, the gradient of 50/1,000 or less. However, this will not be applied to the orbital radius of curvature of entrance to the garage, etc.
4. **"Gauge"** stipulated in design Technical Regulation Article46-1-(3) must be 508mm, 610nn and 762mm in principle.
5. **"Cant shall be provided"** stipulated in design Technical Regulation Article46-1-(4) means that it meets the following requirements;

(1) Kant must be its whole length when there is a relaxation curve length, it must be more than 300 times of Kant in a straight line from the start and end point of the curve when there is no relaxation.

(2) The calculation formula of Kant must conform to the following.

$$C = \frac{v^2 \times G}{0.127 \times R}$$

Where

C	: Kant	(mm)
V	: Average speed of each train during curving	(km/h)
G	: Gauge	(mm)
R	: Radius of curvature	(mm)

6. **<u>"Slack shall be provided"</u>** stipulated in design Technical Regulation Article46-(5) means that it meets the following requirements;

(1) Slack must be the 30mm maximum expanding in the trajectory relative to the outside rail.

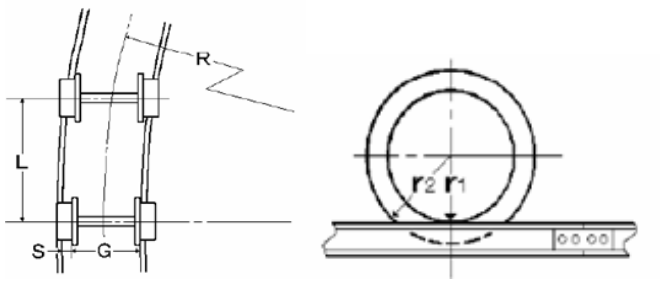
(2) The reduction distance of slack must be its whole length when there is relaxation curve, must be same as the reduction distance of Kant when there is no relaxation curve.

(3) The calculation formula of Slack must conform to the following.

$$S = \frac{\left(L - \sqrt{r_2^2 - r_1^2}\right)^2}{2 \times R + G}$$

Where

S	: Slack	(cm)
L	: Wheel base	(cm)
R	: Radius of curvature	(cm)
G	: Gauge	(cm)
$r1$	: Radius of road surface (wheel)	(cm)
$r2$	: Radius of flange	(cm)



<u>Fig- 3: Dimentions</u>

7. **"A point switch or other truck equipment and automatic alarm sign"** stipulated in design Technical Regulation Article46-(6) means the point which are provided in part rail branch, railroad switch and buffer stop which is provided at the end of orbit, etc. However, this does not applied for a branch point something to relocate frequently such in drilling location.
8. **"The brake"** stipulated in design Technical Regulation Article46-(7) means that it meets the following requirements;

(1) The hand-brake or foot-brake (hereinafter so called the "hand-brake, etc) must be provided for the locomotives.
(2) The power drive brake must be provided for the locomotive of more than 10t weight or maximum speed 15km/h in addition to (1).
(3) The brake for locomotives which is performed in consolidation operation must be capable to balance braking force and must have the structure that can be synclonized by the driver of one operation.
(4) When power drive brake is applied, the percentage between total pressure acting on the shoe of brake (the equivalent force in case no use of brake shoe) and weight of the locomotive must be exceed 70/100 and more than 115/100 in case of power drive break, 20/100 and more in case of hand brake.
(5) The proportion of (4) must be 50/100 and more for the hand brake on the locomotive which has no power drive brake.
(6) In calculating the pressure acting on the brake shoe for break must be pursuant as follows;

1) The cylinder pressure for air brake must be the following pressure.
   a. Direct type air brake
      (a) The adjusted decompressor pressure if there is decompressor.
      (b) The inlet pressure of pressure governor if there is no decompressor.

   b. Automatic air brake
      (a) The balanced pressure of brake cylinder at normal braking

2) The cylinder pressure of steam brake must be 90/100 of the maximum pressure of boiler.
3) The braking force applied to the handle of manual brake 30kg in case of one hand, 45kg in case of both hands and 60kg in case of foot brake.
4) The efficiency of each part must be that percentage as listed below.
   a. 100/100 in case of power brake
   b. In case of manual break;
      (a) 30/100: spiral
      (b) 90/100: gear
      (c) 85/100: bevel gear
      (d) 70/100: iron chain winding

(e) 90/100: lever and crank

(f) 85/100: brake shaft under the floor

(3) In the hand brake, the braking leverage must be 1,200 times or less.

9. **"A headlight"** stipulated in design Technical Regulation Article46-(8) must be provided to the traveling direction of train and has sufficient brightness to identify the obstacles in the direction where traveling, if braking.

10. **"Equipment will also eliminate obstacles on the surface of the rail head"** stipulated in design Technical Regulation Article46-(8) must be provided for locomotive with weight of 5t and more which has greater risk of derailment due to obstacles on the top of rail.

11. **"Other equipment necessary for safe operation"** stipulated in design Technical Regulation Article46-(8) means that it meets the following requirements;

(1) The speedometer provided in driver's seat when operation speed of the locomotive is 20km/h and more

(2) Warning device with sufficient volume to alarm

(3) The tail light to prevent collision

(4) The sand spreader which is easy to operated from the driver's seat and can be operated reliably in the forward and reverse in case of the locomotive exceed 5t and more.

12. **"Structure in which the driver is capable to overlook easily in the advance direction and to perform safe operations"** stipulated in Technical Regulation Article46-(10) means that measures are taken such as providing a fence to prevent the fall of driver.

13. **"The maximum number of vehicles coupled with locomotive"** stipulated in design Technical Regulation Article46-(11) Must be calculated using the following formula;

$$W\max = \frac{\frac{Tm}{R} - mt}{Wk + Wc}$$

$$Tm = 9806.65 \times mt \times \mu$$

$$R = Rr + Rc + Rg + Rd$$

$$Rr = 9806.65 \times k$$

$$Rc = 9806.65 \times \frac{B}{5r}$$

$$Rg = 9806.65 \times P$$

$$Rd = 304.01 \times d$$

Where

Wmax	: Maximum number of combination vehicle	—
Tm	: Maximum tractive force	(N)
mt	: Maintenanced locomotive weight	(t)
μ	: Adhesion coefficient	—

State of rail surface	In normal cases	In sanding case
Dry, clean	0.25 ~ 0.28	0.30 ~ 0.35
Wet thin	0.15 ~ 0.18	0.20 ~ 0.22
In the mine	0.18 ~ 0.20	0.22 ~ 0.25

R	: Total train resistance	(N/t)
Wk	: Weight of a vehicle	(t)
Wc	: Load weight of a vehicle	(t)
Rr	: Travel resistance	(N/t)
Rc	: Curve resistance	(N/t)
Rg	: Grade resistance	(N/t)
Rd	: Acceleration resistance	(N/t)
k	: Coefficient of friction between wheel and rail (0.01 foe roller bearing)	—
B	: Wheelbase	(m)
r	: Radius of curvature track	(m)
P	:Maximum grade of track (horizontal distance/vertical distance)	—
d	: Acceleration of locomotive	(km/h/s)

14. **"An automatic circuit-breaker"** stipulated in design Technical Regulation Article46-(12)-1) must include a fuse in battery type electric locomotive.
15. **"If the train line is long"** stipulated in design technical Regulation Article46-(12)-2) generally means the case of 100m and more, although it is little bit different in terrain, a lot of lighting in rural regions.
16. **"Safety distance"** stipulated in design Technical Regulation Article46-(12)-3) means that it has a separation distance of at least 0.3m.
17. **"To prevent fall"** stipulated in design Technical Regulation Article46-(13) means the state that the protection equipments to prevent falling are facilitated within a range of wagon and 0.3m respectively from each side of the vehicle.

18. The special coal wagon which is used for long distance transportation is illustrated in Photo-26, 27, 28 and 29.

Photo- 26: Coal wagon (1)

http://www.irsgroup.eu/files/content/01_IRS%20Railcars/00%20Hopper%20wagon%20IIA%20Coal%20Hopper.jpg

Photo- 27: Coal wagon (2)

http://farm3.static.flickr.com/2571/3711196686_e961e67a23.jpg

Photo- 28: Coal train

http://s0.geograph.org.uk/photos/36/22/362267_3b1124c3.jpg

Photo- 29: Coal wagon (3)

http://thuongmai.vn/Vung-Tau-Logistics/English/images/stories/Thang-08-2011/25799bc9c6coal-train-photo.jpg

Article 47. Vehicle

Article 47-1. Requirement for vehicle

1. **"Appropriate shock absorber"** stipulated in design Technical Regulation Article47-1-(2) means the proper shock absorber which conform to the safety standards for road vehicles.
2. **"Shall have the necessary Stability"** stipulated in design Technical Regulation means that it meets the following requirements. In addition, the stability must be estimated by calculation.

(1) The sum of load which is applied to the ground where steering wheel seats in the state of empty or loaded must be greater than 20% of the vehicle weight or gross vehicle weight (18% in case of three-wheeled vehicle).

(2) The tractor must conform to the standard (1) in case that the towed vehicle is connected.

(3) The vehicle (excluding motorcycles and towed vehicles) must not fall when tilting up to 35 degree to the right and left (30 degree in case of the vehicle with maximum speed 20km/h or less, vehicle which gross weight is less than 1.2 times of vehicle weight or vehicle with weight more than 20t).

(4) The tractor must conform to the standard (3) in the coupled state with empty tow vehicle.

3. **"A structure and performance to withstand the required travelling"** stipulated in design Technical Regulation Article47-(4) means that it conforms to the safety standards for road vehicles.
4. **"The breaks"** stipulated in design Technical Regulation Article47-(5) means hat meets the requirement as follows;

(1) The brakes can withstand robust enough to run, and must be attached to avoid potential damage due to contact, vibration and shock, etc.
(2) The brake must have structure and performance that has not hurt the steering performance.
(3) The main brake (which are used at all times while driving a vehicle, herein after the same) must be capable to brake the wheels more than half including rear wheels.
(4) The main brake must have the capability to stop the vehicle within the stopping distance listed in the right column of Table-7 depending on the maximum running speed of the vehicle in the left column, the initial braking speed in the middle column in the table below in a flat and dry pavement.

Table- 7: Speed and stopping distance

Maximum speed(km/h)	Initial speed of braking(km/h)	Stopping distance(m)
80 ≤ V	50	22 and more
35 ≤ V< 80	35	14 and more
20 ≤ V<35	20	5 and more
V < 20	Its maximum speed	5 and more
Note-1: The driver's operation force must be 90N or less in case of foot type, 300N or less in case of manual type.		

Reference: Section-7 of technical guidrline for technical regulation of mining facility Japan

(5) The main brake on over 20t of gross vehicle weight has the capability to stop the vehicle within the stopping distance listed in the right column of Table-8 depending on the vehicle weight listed in the left column of following Table-8 in a initial aped of braking of 32km/h and in a flat and dry pavement.

Table- 8: Gross vehicle weight and stopping distance

Gross vehicle weight(t)	Stopping distance(m)
180 ≤ W	53 or less
90 ≤ W < 180	38 or less
45 ≤ W < 90	27 or less
W < 45	18 or less

Reference: Section-7 of technical guideline for technical regulation of mining facility Japan

(6) The brakes (one of the systems, if there are at least two braking systems) must have the capability to hold stall state of empty vehicle on the pavement with dry 1/5 gradient by mechanical action when the driver is not in the seat. In this case, the driver’s operating force must be 900N or less in case of foot-brake, 500N or less in case of manual-brake.

5. **“Travelling gear”** stipulated in design Technical Regulation Article47-(6) means that it conforms to the safety standards for road vehicles. **“The steering equipment”** stipulated in design Technical Regulation Article47-(7) means that meets the requirement as follows;

(1) The steering system must be robust and can be secure safety driving.
(2) The steering system must be capable to operate easily and reliably in the place.
(3) The steering system must be no contact with frame, fender and other parts of the vehicle when steering a car.
(4) There must be no significant difference relation ship with the rotation angle of steering handle and steering wheels on the right and left.
(5) There must be no significant difference of the steering force for right and left.

6. **“The operation system which is necessary for driving”** stipulated in design Technical Regulation Article47-(8) means that are listed as follows;

(1) Starting system, accelerator, crutch, power transmission control device and other operation system for prime mover and transmission device
(2) Break operation system
(3) Headlamps, alarm horn, turning signals, window cleaner equipment, operation device for cleaning liquid injection system and defroster (which means device for removing water droplets on the front glass such as flog)

7. **“Shall be placed in the appropriate position”** stipulated in design Technical Regulation Article47-(8) means that handles are located within 600mm from the center of the right and left of steering wheel.
8. **“The vehicle locking device”** stipulated in design Technical Regulation Article47-(9) means that it conforms to the safety standards for road vehicles.
9. **“Shall be arranged with no fear of harming a human being”** stipulated in Technical Regulation Article47-(10) means that meets the requirement as follows;

(1) The exhaust pipe must be open to the right and left.
(2) The exhaust pipe must not be within the passenger compartment.

10. **"Prevent the driver from driving maneuvers or carrying goods"** stipulated in design Technical Regulation Article47-8 means that meets the requirement of road vehicle.
11. **"Safety glass"** stipulated in design Technical Regulation Article47-9 means that it conforms to the safety standards for road vehicles.
12. **"Head light"** stipulated in design Technical Regulation Article47-10 means that meets the requirement as follows;

(1) The automobile headlamps of vehicle (except tractors, same in the (2)) must have the capability to determine obstacles at a distance of 100m ahead traveling at night.
(2) The automobile headlamps must have structure which can be reducing light, converted into a downward direction or irradiation to avoid interfering with other vehicles, etc.

13. **"Tail light"** stipulated in design Technical Regulation Article47-10 means that meets the requirement as follows;

(1) The taillight must be those which can be seen at night from a distance of 300m.
(2) The color of taillight must be red.

14. **"Brake lights"** stipulated in design Technical Regulation Article47-10 means that meets the requirement as follows;

(1) The break light must be provided in the rear of car.
(2) The break light must be capable to see during daytime from a distance of 100m.
(3) The break lamp (except break light combination with taillight) must have structure which is illuminated only when main break (in the case where the towed vehicle and coupled to towing vehicle's main break means a vehicle towed or towing vehicle) or auxiliary break (means retarder, exhaust break, break which assist main break for slowing down n the vehicle while driving) is operated.
(4) The taillight combination with break light must have structure which increase more than 5 times fold in light intensity when illuminating at the same time.

15. **"Reverse light"** stipulated in design Technical Regulation Article47-10 means that is lit only when transmission (the tow vehicle transmission in case of the vehicle is towed) is in the reverse position. However, in case of towed vehicle to be towed by motorcycles, this does not be applied.
16. **"Horn"** stipulated in design Technical Regulation Article47-10 means that meets the requirement as follows;

(1) The loudness of alarm hone (if more than 2 horns working together, alarm sounds must be the sum of

two) must be greater than 90dB at 2m in front of the vehicle position (proper loudness in the maximum travelling speed less than 20km/h).

(2) The warning sound of alarm horn must be continuous and loudness and tone be a constant.

17. **"Mirror"** stipulated in design Technical Regulation Article47-10 means that it can be seen the line outside of the right and left rear of vehicle (the tow vehicle transmission in case of the vehicle is towed) and vehicle listed as below (except for those structures and towed vehicle can be checked directly any obstruction near the front wheel and the car just before the driver's seat when the driver in the driver's seat), the back mirror must be provided.

(1) Ordinary vehicle with gross weight 8t and more and with maximum loading weight 5t and more

(2) Vehicle with seating capacity of 11 and more

18. The vehicle must use appropriate fuel oil which is conformed to JIS K2204 "light oil".

19. The appropriate concentration of exhaust gas means that it meets the following requirements;

(1) The value which is obtained by multiplying the measured value 1.355 represented by the volume ratio of carbon monoxide contained in exhaust gas discharging from into atmosphere in the no load operation of prime mover must be 0.06% or less.

(2) The measurement of carbon monoxide must be performed according to JIS K0098 (analysis method of carbon monoxide in the exhaust gas) of Japanese Industrial Standard or the measurement method with an accuracy of equivalent or higher standards of measurement methods.

20. The black exhaust smoke from vehicle must be reduced by the exhaust gas emission control device such as ceramic filters, water scrubber, and oxidization catalyst device.

21. The vehicle which is used for sort or middle distance transportation of coal is shown in Photo-30, 31, 32 and 33.

Photo- 30: Coal trailer (1)

http://www.hankstruckpictures.com/pix/trucks/r_mohr/2004/mar/atkinson_coal_truck_dapto.jpg

Photo- 31: Coal trailer (2)

http://www.hankstruckpictures.com/pix/trucks/kristyas_orisanto/2007/03-15/patria-side-dump-trailer.jpg

Photo- 32: Dump trailer (1)

http://www.kalmn.com/p/dump-trailer.jpg

Photo- 33: Dump trailer (2)

http://i01.i.aliimg.com/img/pb/841/142/385/385142841_344.jpg

Article 48. Vehicle type mining machines

Article 48-1. Requirement for vehicle type mining machines

1. **"A vehicle type mining machine"** stipulated in design Technical Regulation Article48-1-(1) means those of listed as follows;

(1) Loading machine
   1) Tractor shovel
   2) Continuous loading machine
   3) Loader

(2) Transportation machine
   1) Shuttle car
   2) Road-haul dump
   3) Low-floor dump truck
   4) Rough terrain vehicle

(3) Other machine
   1) Bulldozer
   2) Motor grader
   3) Crane
   4) Scraper
   5) Scrapedozer

2. The vehicle type mining machine must have the stability that meets following requirements.

(1) Bulldozers, motor graders, scrapers, scraper dozer and rough terrain vehicles which equipped full weight such as motor, fuel for fuel system, cooling water, etc., equipment and device necessary for the purpose of mining equipment must have stability on a horizontal and robust surface even inclined

to 35° (30° in case the ratio between "Net weight" and "Total weight "is 1.2 or less). Furthermore, such stability can be estimated by calculation.

(2) The shovel loader and fork loader must have the front, rear, right and left stability of falling in and around the floor of gradient listed in the right column of Table-9 in the state prescribed in the middle column in the same table according to the classification of stability in the left column of the table set forth below.

Table- 9: Stability

Classification of stability	State of shovel loaders, etc.	Slope (%)	
		Shovel loaders	Fork loader
Stability in back and front	Condition that the maximum horizontal distance between fork or shovel and body	15	7
	Standard no-load condition	30	24
Stability in right and left direction	Highest state of the raised shovel or fork from standard no-load condition	20 (15: in the shovel loaders with the maximum load is less than 2t)	15 (12: in the folk loader with the maximum load is less than 2t)
	Standard no-load condition	60	55
Remarks-1. In this table, standard condition means the state that load maximum load on the defined gravity center and was raised to the minimum height of shovel loader (which means the height of lowest point from ground except rest point on the ground) in case of shovel loader. However, if it is a shovel loader which has reach equipment, it must be returned to fully.			
Remarks-2. In this table, standard non-load condition means the state that shovel is tilted up to later and lowest part is raised to lowest height from ground. However, if it is a shovel loader which has reach equipment, it must be returned to fully.			

Reference: Section-8 of technical guideline for technical regulation of mining facility Japan

3. **"Brake system"** stipulated in Technical Regulation Article48-1-(3) means that conforms to the following requirements;

(1) The brake for stopping the travel of vehicle must have the performance that has to be capable to stop vehicle within a stopping distance as shown in Table-10 depending on the maximum speed in the left column and the initial speed of braking in the middle column in the flat and dry pavement.

Table- 10: Speed and stopping distance

Maximum speed (km/h)	Initial speed of braking (km/h)	Stopping distance(m)	
		In case total machine weight 20t or less	In case total machine weight 20t and more
35 ≤ V	35	14 or less	20 or less
20 ≤ V < 35	20	5 or less	8 or less
V < 20	Its maximum speed	5 or less	8 or less

Reference: Section-8 of technical guideline for technical regulation of mining facility Japan

(2) The brake to hold the state of stopping must have the performance that can be maintained unloaded mining type vehicle in stopping state on the 1/5 slope.

(3) The break for stopping the traveling of shovel loader must have the performance that has to stop vehicle within a stopping distance as shown in right column of Table-11 depending on the initial speed of braking as shown in middle column and the state as shown in left column.

Table- 11: Initial speed of braking and stopping distance

State of shovel loader, etc.	Initial speed of braking(km/h)	Stopping distance(m)
Standard no-load condition	20 (the maximum speed in case shovel loader of the maximum speed is less than 20km/h)	5
Standard load condition	10 (the maximum speed in case shovel loader of the maximum speed is less than 10km/h)	2.5
Note: In this table, standard no-load condition and standard load condition means the state as stated in Table-9.		

Reference: Section-8 of technical guideline for technical regulation of mining facility Japan

(4) The brake to hold shovel loader the state of stopping must have the performance that can be maintained the state of stoppage in the slope on the slope as shown in right column of Table-12 depending on the situation as shown in left column.

Table- 12: Slope and brakes

State of shovel loader, etc.	Slope (%)
Standard no-load condition	20
Standard load condition	15

Reference: Section-8 of technical guideline for technical regulation of mining facility Japan

4. The vehicle type mining machine must use appropriate fuel oil which is conformed to JIS K2204 (light oil).

5. The appropriate concentration of exhaust gas means that it meets the following requirement;

(1) The construction machines which is designated by Japanese MITI as construction machine for tunnel with emission measures must be used.

(2) The vehicle type mining machine other than (1) and which has the smoke purification equipment for the engine must be conformed to the emission criteria for each category listed in left column of the output of the engine and must be used the smoke purification equipment to suit following requirements.

1) The each concentration of black smoke at rated point, intermediate point, and full load point, transient point is reduced is reduced and it must be less than one fifth of the maximum after installation of purification equipment compared with the maximum value prior to installation.
2) The weight of hydrocarbons, nitrogen oxides, carbon monoxides and particular matters in the emission gas must not increase by installation of purification equipment.

Table- 13: Emission limits (1)

Type of exhaust gas Division of prime mover output	Hydrocarbon	Nitrogen oxide	Carbon monoxide	Particle matter	Graphite
8kW ≤ P < 19kW	7.5		5.0	0.8	40
19kW ≤ P < 37kW	1.0	6.0	5.0	0.4	40
37kW ≤ P < 56kW	0.7	4.0	5.0	0.3	35
56kW ≤ P < 75kW	0.7	4.0	5.0	0.25	30
75kW ≤ P < 130kW	0.4	3.6	5.0	0.2	25
130kW ≤ P < 560kW	0.4	3.6	3.5	0.17	25
Note: The unit g/kwh is applying hydrocarbons, nitrogen oxides, carbon monoxide and particulate matters and % for black smoke.					

Reference: Section-8 of technical guideline for technical regulation of mining facility Japan

(3) The vehicle type mining machine other than (1) and which has the smoke purification equipment for the engine listed in the Table-13 of (2) must be conformed to the one fifth of black smoke emission criteria for each category listed in left column of the output of the engine and must be used the smoke purification equipment.

(4) If it cannot be applied above (1) through (3), the followings must be applied.

1) The vehicle type mining machine which output is more than 19kW and less than 560kW must meet the emission criteria listed for each type of emission for each category listed in the left column of Table-13 and must use qualified black smoke purification equipment. However, if there is no qualified black smoke purifier equipment, this must not be applied.
2) Those stipulated in following (5) can be used for output more than 8kW and less than 19kW.

(5) The vehicle type mining machine stipulated in ordinance of Mining Safety Act and which has engine of more than 8kW and less than 19kW can be used followings other than (1) to (4).

1) The construction machine for tunnel and vehicle type mining machine must be conformed to the emission criteria for each category of the output of the engine listed in left column of Table-14 and must be used the smoke purification equipment to suit following requirements;

a) The each concentration of black smoke at rated point, intermediate point, and full load point, transient point is reduced is reduced and it must be less than one fifth of the maximum after installation of purification equipment compared with the maximum value prior to installation.

b) The increase of amount of hydrocarbon must not exceed 0.1g/kWh, nitrogen oxide 0.3g/kWh, carbon monoxide 0.3g/kWh by the black smoke purification equipment.

Table- 14: Emission limits (2)

Type of exhaust gas / Division of prime mover output	Hydrocarbon	Nitrogen oxide	Carbon monoxide	Particle matter	Graphite
8kW ≤ P < 19kW	1.5	9.0	5.0	0.8	40
19kW ≤ P < 37kW	1.5	8.0	5.0	0.8	40
37kW ≤ P < 75kW	1.3	7.0	5.0	0.4	40
75kW≤ P < 130kW	1.0	6.0	5.0	0.3	40
130kW≤ P < 560kW	1.0	6.0	3.5	0.2	40

Note-1. The unit g/kwh is applying hydrocarbons, nitrogen oxides, carbon monoxide and particulate matters and % for black smoke.

Note-2. Determination of hydrocarbons, hydrocarbons, nitrogen oxides, carbon monoxide and particulate matters must be done according to JIS B8008-1 (Reciprocating internal combustion engines - Exhaust emission measurement –Prt-1)

Note-3. Measurement of black smoke is according to standard T04-1995 (Diesel engines for construction equipment – measuring method of emissions) provided by Japan Construction Mechanization Inc.

Reference: Section-8 of technical guideline for technical regulation of mining facility Japan

6. **"Safety equipment"** stipulated in design Technical Regulation Article48-1-(4) is interpreted that the safety is ensured without such equipment when it conform to follows.

(1) Headlight for vehicle which is used in the place where necessary illumination is held for safe work.

(2) Turning signal for vehicle type mining machine which reciprocating engine is not applied as the prime mover, caterpillar type vehicle type mining machine, vehicle type mining machine with

maximum speed less than 10km/h, which distance is less than 650mm from the driver's cabin or center of steering wheel to the outmost of vehicle and is used only in indoor and no driver's cabin.

(3) Horn for the mining type vehicle which reciprocating engine is not applied as the prime mover.

(4) Speedometer or over-speed alarm for rough terrain vehicles with maximum speed less than 20km/h.

7. **"Appropriate measures"** stipulated in design Technical Regulation Article48-1-(6) means that the lifting equipment is provided if the floor of driver's seat is exceeded 1.5m height. However, this must not be applied if it has become a structure to be capable of safety lifting the driver.

8. **"Safety glass"** stipulated in design Technical Regulation Article48-1-(7) means that conform to the standard JIS R3211 "Safety lass for vehicle" or equivalent. Furthermore, the reinforced glass must be used in the cabin of breaker and the equipment which prevents hazards due to flying objects must be provided.

9. **"Shall be displayed in the correct place"** stipulated in design Technical Regulation Article48-(9) means that followings;

(1) The following matters must be indicated in the driver's viewing position for the mining type vehicle (except vehicle which does not use internal combustion engines as prime mover, shovel loader, forklift and aerial work platform). However, in the matters listed in ⑦, this does not be applied to roller.

1) Name of manufacturer
2) Manufacturing date and serial number
3) Body weight or gross weight of machine
4) Rated output
5) Maximum speed
6) Mean contact pressure
7) Capacity of bucket, dipper or maximum loading capacity in driver7S viewing position in addition to the matters listed in the preceding item in case the mining type vehicle which has bucket, dipper and shovel, etc.

(2) The following matters must be indicated in the driver's viewing position for shovel loaders, etc.

1) Name of manufacturer
2) Manufacturing date and serial number
3) Maximum weight or maximum load that can be loaded on the standard loading center of prescribed gravity center when extended to maximum reach in case equipped with reach equipment.
4) Shovel capacity in case of shovel loader

10. Bulldozer, shovel loader and scraper, etc. which are used for transportation of coal in the coal yard are shown in Photo-34, 35, 36 and 37.

Photo- 34: Bulldozer (1)

http://www.bristolport.co.uk/a/images/gallery/coal8-large.jpg

Photo- 35: Bulldozer (2)

http://lh5.ggpht.com/-E0X5dFDBUL8/TLFCqj6ZKXI/AAAAAAAAAAJ0/8qkNiY73upc/_MG_4548.jpg

Photo- 36: Shovel loader

http://www.flickr.com/photos/wonderbuildings/5208742594/

Photo- 37: Scrapedozer

http://www.cat.com/cda/files/2056998/7/coalbowlscraper.jpg

One-way transportation distance of 50~60m is appropriate for bulldozer. In this method, it can be compressed coal in the coal yard; there are advantages such as preventing deterioration and spontaneous combustion of coal. On the other hand, there is a problem high operating costs, jamming in low-grade coal and is difficult blending.

Article 49. Wagon damper and truck dumper

Article 49-1. Rotary wagon dumper

1. There are two types, falling sideway and rolling, for wagon dumper as shown in Photo-39 and 40 when classifying on the mechanism. When transporting coal over long distances towards the loading ports and consumption from coalfield area, the unit train which are organized in the same type and size wagons as shown in Photo-41 is employed in order to unload coal efficiently as shown in Photo-38, 39, in that case rotary coupler as shown in photo-42, 43 are used as wagon coupling. The falling sideway type is not used for the unit train in terms of continuity even if it is used for coal field dumping. Coal dropped into the hopper below the dumper will be transported to intermediate storage

or coal storage bunker by conveyor automatically.

Photo- 38: Wagon dumper (1)

http://www.mme.co.za/images/eng_pic_02.jpg

Photo- 39: Wagon dumper (2)

http://2.bp.blogspot.com/_IPZX1n_gnIM/TLVXoag5D7I/AAAAAAAAGRk/iRxclFhgVpE/s400/Rotary+Dumper.jpg

Photo- 40: Wagon dumper (3)

http://incebps.org.uk/images/Coal_Wagon_Tippler.JPGp

Photo- 41: Wagon with rotary coupler

http://livedoor.2.blogimg.jp/dda40x/imgs/1/e/1e672116.jpg

Photo- 42: Rotary coupler (1)

http://www.mcconway.com/rail_prod/rotary/rotary.htm

Photo- 43: Rotary coupler (2)

http://www.railpage.com.au/f-p1556534.htm

Article 49-2-1. Bottom discharge coal wagon

1. The bottom open type coal wagon as shown in Photo-46, 47 is led to the elevated station as shown in Photo-44 and unloaded to the ground or underground hopper below track as shown in Photo-45. It is

necessary to move coal from the place below truck by bulldozer in the former case; it is required transportation facility to send coal storage hopper to coal storage yard in the latter case.

Photo- 44: Bottom discharge coal wagon (1)

http://myfavoritessite.sakuraweb.com/japanFromSky/doutou/doutou03.jpg

Photo- 45: Bottom discharge coal wagon (2)

http://www.sekitanland.com/hg/img/yard.jpg

Photo- 46: Bottom discharge coal wagon (3)

http://homepage2.nifty.com/kitaqare/images/mido07047.jpg

Photo- 47: Bottom discharge coal wagon (4)

http://farm2.static.flickr.com/1096/4727591722_3ed3d5de56.jpg

Article 49-2-2. Side discharge coal wagon

1. The side open coal wagon as shown in Photo-48, 49 is led to elevated station and is unloaded to ground; discharged coal is moved only by bulldozer because it can not be unload into underground hopper directly.

Photo- 48: Side discharge coal wagon (1)

http://jrvec.com/product_view.aspx?id=48

Photo- 49: Side discharge coal wagon (2)

http://www.railwaywagon.org.cn/images/2005728163944515_c64k.jpg

Article 49-3. Truck hopper and truck dumper

1. The damping facility is required in order to perform rapid unloading for trucks. If the vehicle is capable of dumping, the receiving hopper and transportation conveyor as shown in Photo-50 is necessary. In addition, the truck dumper as shown in Fig-4 is required, if the truck has not a dumping function.

Photo- 50: Truck chute

http://www.fukushimakodomo.net/staff/media/1/20090903-19.jpg

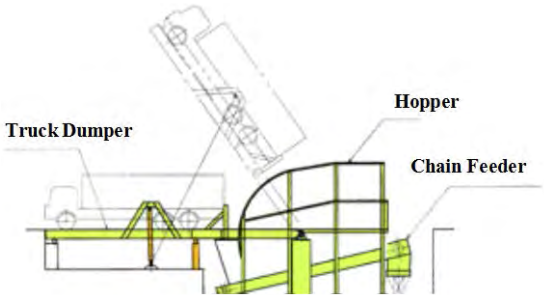


Fig- 4: Truck dumper

http://www.akse.jp/incidental/track_damper/

Article 50. General provision of coal storage facility

Article 50-1-1. Coal storage system

1. The typical flow and configuration of facilities when receiving coal by the land transportation such as railway and transport to bunker after a once storage in outdoor storage yard is shown in Fig-5.

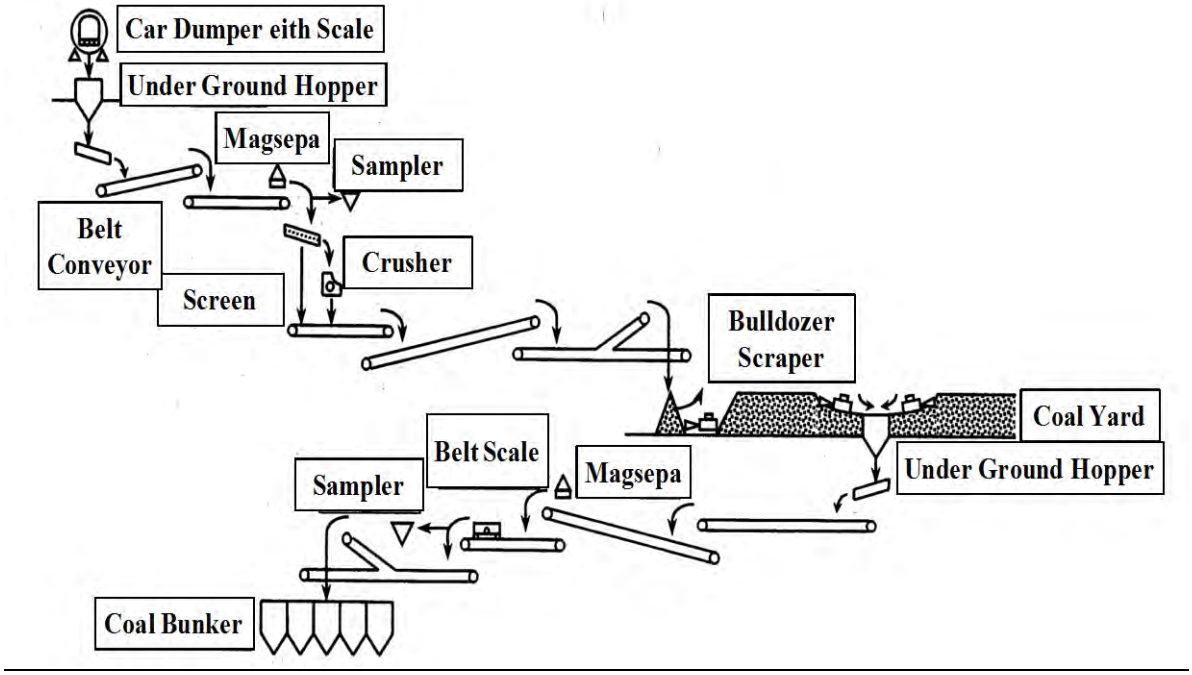


Fig- 5: Flow sheet of outdoor coal storage yard (type-A)

Reference: P-141 of Journal (No.516: Sept. 1999): TENPES

2. The typical flow and configuration of facilities when receiving coal by sea transportation such as ocean vessel or domestic vessel and transport to bunker after a once storage n outdoor storage yard is shown in Fig-6.

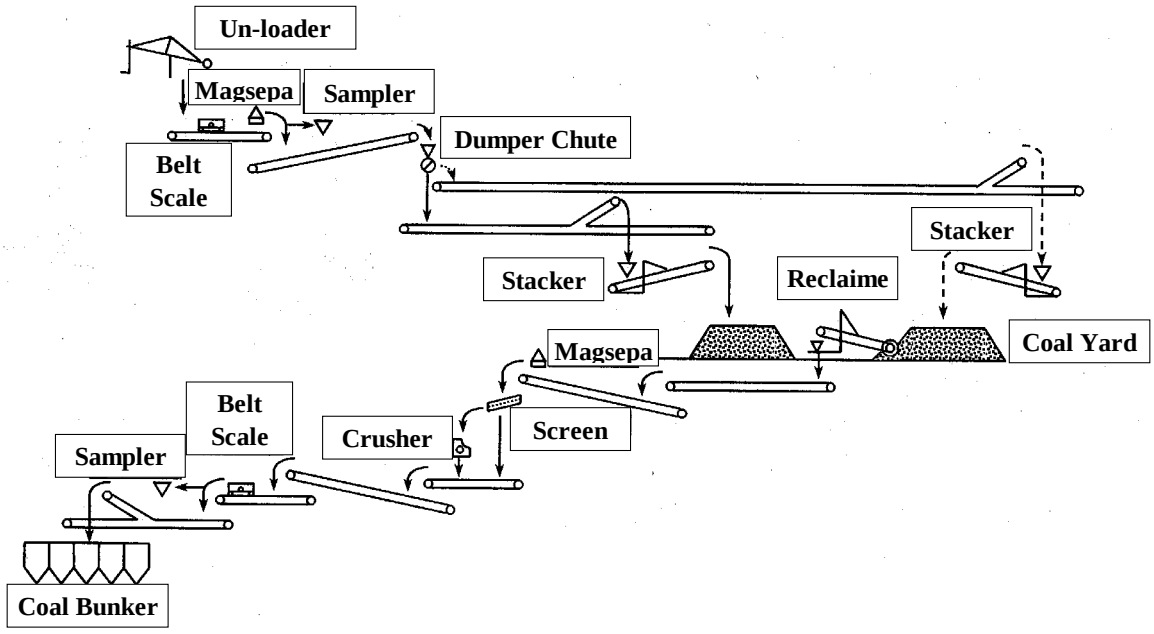


Fig- 6: Flow sheet of outdoor coal storage yard (type-B)

Reference: P-141 of Journal (No.516: Sept. 1999): TENPES

Article 51. Outdoor coal storage yard, stacker and reclaimer

Article 51-1. Spontaneous combustion

1. Coal is often stored by pile in the coal bunker (coal yard) until using as the fuel or raw material after loading in the power plants or steel mill plants. At that time, the piled coal eventually reached the critical temperature and causes the phenomenon of spontaneous combustion, since oxygen in the air reacts with highly active hydrocarbon, carbon material or sulfur in the coal and thermal energy by heat storage are increased during storage when coal is left for long periods. In coalfield area, the oxidization phenomena or natural spontaneous phenomenon in underground as shown in Photo-51.

   In general, the coal with high volatile matter and low carbonization or high sulfur is easy to heat up by long term storage. Spontaneous combustion may be caused if neglecting the temperature control. Such fever with a risk of ignition of the storing coal is a major problem for the security and it degrade the quality of coal to not lead to spontaneous combustion, therefore it is important to prevent it. The method to prevent entry of air and moisture to coal layer spraying coating agent (urea powder, urea solution) such as Table-15 on the surface of coal piles, the method to splaying for example Latex, the method to spaying cement, resin or various resin solution or the method to blow in dry-ice, nitrogen gas, exhaust gas which contains less oxygen, the method to blow in inert gas, the method to press coal pile surface, the method to preventing deterioration of coal quality in combination with resin spraying, the method in combination with resin emulsion and other chemicals, the method spraying water from outside of coal pile or the method injecting pressure water into coal layer are employed as measures than before. It is preferable to monitor temperature of storing coal by the monitoring facility as shown in Fig-7.

Table- 15: Coating agent for coal

No.	Agent		Rate of oxygen uptake (mg-O2/min・200g-coal)	Oxygen absorption inhibition ratio (%)	Effect against conventional method (%)
	Type	Application ratio (W %)			
1	No-treatment		0.42	—	—
2	Water		0.39	7.1	—
3	Acrylic emulsions	0.0005	0.35	16.7	—
4	Anionic surfactants	0.0005	0.38	9.5	—
5	SBR latex	0.0005	0.28	33.3	20
6	Ethylene vinyl acetate emulsion	0.0005	0.33	21.4	—

http://image.astamuse.com/image/JP/0003/948/447/B2/000002.png

Photo- 51: Under-ground coal fire

http://farm3.static.flickr.com/2036/1505970514_ef2c051168.jpg

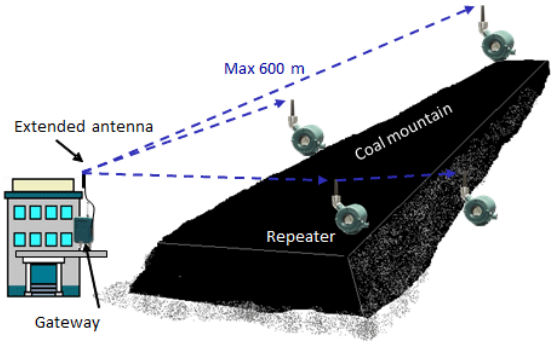


Fig- 7: Coal storage temperature monitoring

http://www.field-wireless.com/en/solutions/solution01.html

2. When heating a substance in air, the temperature of the fire begins to burn without an ignition originates is called the ignition temperature and ignition point, however, it depends on measurement conditions in the same material. The approximate value is 225°C in dry wood, 330°C in dry coal, 360°C in charcoal, 700°C in coke. It is necessary to extinguish fire quickly at the time when igniting the surface, since it is impossible to extinguish fire to inner part if large amount of coal is stored. Therefore, it is necessary to provide the sprinkler or fire extinguish water equipment as shown in Photo-52, 53 also dust prevention measures.

Photo- 52: Coal yard fire fighting piping

http://www.jewa-hp.jp/topics/images/okinawa/02_12.jpg

Photo- 53: Coal yard sprinkler

http://www.irrigationwarehouse.com.au/images/p1-high-wind-coal-pile.jpg

Article 51-2. Measure for coal dust

1. Prevention of dust

It is necessary to consider the adoption of continuous and sealed for the unloader as well as watering to the excavation part. In addition, it is preferable to close belt conveyor, to provide sprinkler and dust collector for transition part, to watering to excavation part and discharging part of stacker and declaimer, to provision of wind break fence and sprinkler of coal yard as shown in Photo-54, 55, 56 and 57.

Photo- 54: Sprinkler for coal conveyor

http://www.firefighting.in/img/MVWS_for_coal_conveyor.jpg

Photo- 55: Wash down piping for coal conveyor

http://www.ryanwilks.com.au/2011/08/22/wallerawang-power-station-conveyor-coal-wash-down-pipework-installation/

Photo- 56: Windbreak net

http://securitymeshfence.com/upfiles/image/2011/04/16/20110416011359593.jpg

Photo- 57: Sprinkler for coal yard

http://www.energytribune.com/live_images/ET121108_china.jpg

Article 51-3. Measure for rainwater

1. Drainage treatment facility for coal storage yard

   It is necessary to treat sprinkled water which used as dust prevention measure and rainwater for the outdoor coal yard which is required strict environmental measures, although the storage in vacancy is applied to reduce cost. In general, the outdoor coal yard has permeable structure as shown in Fig-8, and treated water is reused after treatment and surplus water will be discharge to off-site from power plant.

Photo- 58: Effluent treatment of coal yard

http://www.futaba-mfg.co.jp/business/images/draining_3.jpg

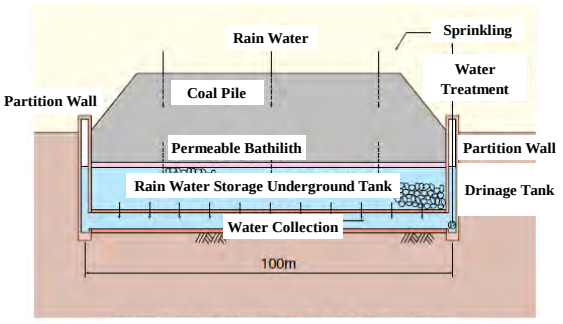


Fig- 8: Effluent treatment of coal yard

http://www.chuden.co.jp/resource/corporate/news_88_N08823.pdf

Article 51-4. Angle of repose

1. The maximum angle formed by free surface of the poser with the horizontal static aquarium state, also known as the "resting angle" or "angle of repose". The angle of repose of powder must be considered ideal to match the angle of internal friction. In the actual powder, the angle of repose is often larger than angle of surcharge as shown in Table-16. There are 1) injection method, 2)discharge method, gradient method as the measurement method angle, the angle of repose measured by the gradient method tend to be smaller than other method.
2.

Table- 16: Angle of repose of coal

Material		Density (kg/m^3)	Angle of repose (degree)	Angle of surcharge (degree)
Coal	Anthracite(≤15mm),	900~1100	37	25
	Bituminous(≤50mm)	~800	36~38	25
	Bituminous, run off mine	720~880	35	25
	Bituminous, slack	690~800	37	25
	lignite, broken	720~880	—	25
	pulverized for coking	400~590	—	10
Coke	run of oven	400~480	30	25
	breeze	380~560	30~45	20

Article 51-5-1. Requirement for outdoor coal storage yard

1. Outdoor coal storage is the most common method used if there is no restriction. As stacking pattern of coal, the compression method or cumulative method may be applied. The cumulative method is general method to accumulate little by little flat, which way to an appropriate height. If making irregular pile or the particle size distribution is imbalanced, it is easy to cause spontaneous combustion and to scatter due to the air flow. The compression method is the method to compact in

layers while lying conditioned by 0.3 to 0.5m height by bulldozer. It is suitable for the long-term storage, since the deposited density is large, internal circulation of air in the coal is interfered and less risk of heating and weathered. The height of coal is subject to restrictions because of spontaneous combustion; it can increase the amount for the same area and is often employed when the coal has mass volume. Notes on coal storage are as follows;

(1) Stacked height must not exceed the proper height, which may be number of several meters to number of 10m. The shallow, easy-to ignite with high volatile matter must be stored in thin layer, the less volatile matter, proceeded carbide coal must be stored in thick layer.

1) In case of compressed coal storage, it must be adjusted compression carefully by height and on the slope. It is important to compress from slope. It is preferable to keep slope angle
2) The drainage of stock yard must be good and sufficient.
3) The discharge from coal yard must be performed without mixing and contacting coals which are received in the different time and different type and must be discharged from the oldest coal as much as possible.
4) The internal temperature of coal must be measured on a regular basis to monitor changes in temperature. The maximum temperature inside the coal is said to have about 1m from the inner surface of pile, it is appropriate to monitor and thermometer inserted into this part. If some part reached to temperature more than 50^{o}C, it must be discharged preferentially or be transshipped. If temperature reached 60 ^{o}C and more, it must be transshipped and watering accordingly. In the event of spontaneous combustion, coal must be cooled by watering with full attention cause any adverse effects as watering. The spontaneous combustion may allow within at least 1 month depending on the type of coal, though it can not be compressed storage by stacker.

2. The characteristics of each coal sample of outdoor storage are organized in Table-17.

Table- 17: Features of outdoor coal storage examples

Photo-59	Short-term interim storage base assuming the rail transport.
Photo-60	Short-term storage in crime state.
Photo-61	Long-term massive storage in large-scale power plant.
Photo-62	Short-term small amount storage using the truck hopper.
Photo-63	Short-term small amount storage in close to crime state reducing moisture absorption due to rain.
Photo-64	Long-term massive storage in large-scale power plant.

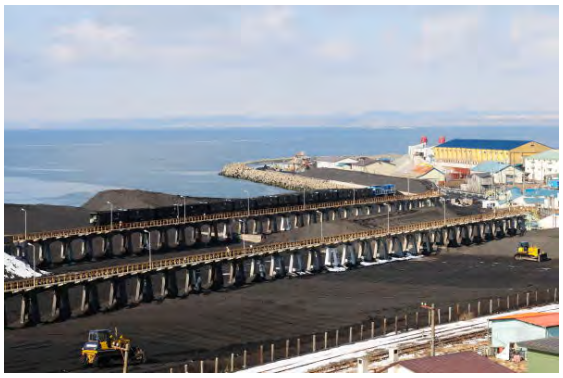


Photo- 59: Outdoor coal storage yard (1)

http://homepage3.nifty.com/nakabexe/DSC_58951.jpg

Photo- 60: Outdoor coal storage yard (2)

http://www.eriding.net/media/photos/environment/power/coal/090407_rfoster_mp_env_power_coal_ratcliffe5.jpg

Photo- 61: Outdoor coal storage yard (3)

http://www.iuk.co.jp/crane/b_conveyor.html

Photo- 62: Outdoor coal storage yard (4)

http://www.edinphoto.org.uk/0_my_p_edwk/0_my_photographs_edinburgh_at_work_-_bruce_lindsay_waldie_qt27_edw097.jpg

Photo- 63: Outdoor coal storage yard (5)

http://artisan-contracting.com/images/project_photos/12%20Lafarge%20Coal%20Storage%20BLDG.jpg

Photo- 64: Outdoor coal storage yard (6)

http://1.bp.blogspot.com/_SQBcWLbkqhY/TNQcZp-4SVI/AAAAAAAABnE/Al5j72jLOBY/s1600/Coal+Yard+view.jpg

Article 51-5-2. Stacker

1. This type is travelling on the rail along the coal conveyor as shown in Photo-65, 66 and Fig-9 which stacks coal via conveyor in the boom which turn and move up and down to outdoor coal storage yard. It is suitable for large capacity coal storage. Currently, a number of stackers with capacity 5,000t/h~6,000t/h class are working. The swing type is used in the silo or dome indoor storage yard. When using the stacker, while coal storage is available to enable the orderly, it is not suitable for small scale storage, since the large capital cost of railroad equipment and attacker unit. This method is employed on be half of the bulldozer, since automation is possible. Width at the bottom of the pile is appropriate in 30m~50m in the aspect of technically and economically in the outdoor coal storage yard.

Photo- 65: Stacker (1)

http://www.greenfuelsfactory.ca/wp-content/uploads/2011/03/coal-stacker.jpg

Photo- 66: Stacker (2)

http://www.usinenouvelle.com/industry/img/stockyard-systems-stackers-000127353-4.jpg

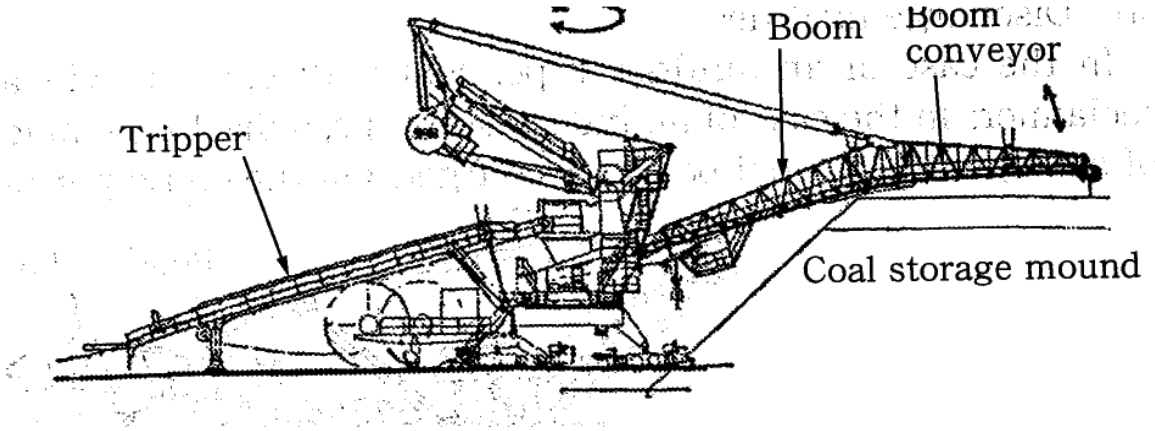


Fig- 9: Stacker

Reference: P-151 of Handbook for thermal power facility Ver.7 2008 TEMES

Article 51-5-3. Stacker and reclaimer

1. This is the dual purpose machine of stacker and reclaimer as shown in Photo-67 and 68, which is used as a stacker for stacking and as a reclaimer for withdrawal in the coal stock yard, if necessary. It

is necessary to make plan utilizing the property as dual purpose, since there are possibility to use with stackers and reclaimers in the same stock yard, use only this type depending on the working conditions and scale. The sample layout of coal receiving and storage facility is shown in Fig-11, 12 in case of outdoor stock yard and indoor stock yard.

Photo- 67: Stacking reclaimer (1)

http://www.thyssenkrupp-materialshandling.co.za/Images/72_70_45_Eskom_Kendal_StackerReclaimer.jpg

Photo- 68: Stacking reclaimer (2)

http://www.ncig.com.au/Portals/2/Images%20for%20Redesign/Stacker%20Reclaimers.jpg

Article 51-5-4. Reclaimer

1. Generally, the reclaimer is the structure which has bucket wheel at the end of the turning boom, moving up and down and travelling on the rail as shown Fig-10 and Photo-70. Usually, it is installed on the opposite side of stacker of the pile in stock yard and cut off coal pile from both sides of the travelling direction. Those of small capacity reclaimer costs expensive, although in some capacity ranging 5,000t/h~6,000t/h, generally, it is appropriate to adopt more than 400~500t/h. The width of pile bottom is appropriate as 30m~50m. The gantry type or swivel reclaimer is used in indoor stock yard. There is other method as shown in Photo-69, 71 that cut out from side and method as shown in Photo-72 that cut out end face.

Photo- 69: Portal reclaimer

http://www.thyssenkrupp-materialshandling.co.za/Images/110_108_47_Portal_Reclaimer_Sasol.jpg

Photo- 70: Bucket wheel reclaimer

http://www.usinenouvelle.com/industry/backhoe-loaders-o704.html

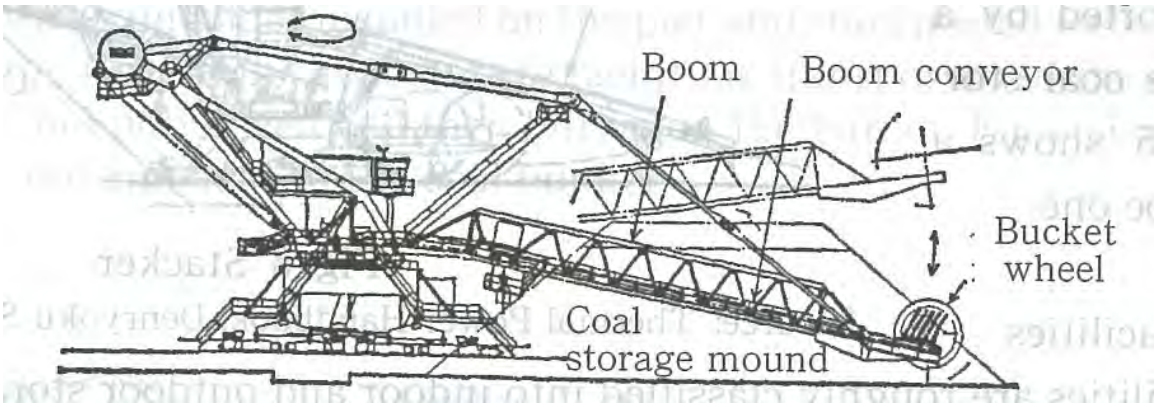


Fig- 10: Bucket wheel reclaimer

Reference: P-151 of Handbook for thermal power facility Ver.7 2008 TEMES

Photo- 71: Twin boom portal reclaimer

http://upload.wikimedia.org/wikipedia/commons/thumb/4/45/Krupp_twin_boom_portal_reclaimer_rtca_kestrel_mine.jpg/300px-Krupp_twin_boom_portal_reclaimer_rtca_kestrel_mine.jpg

Photo- 72: Bridge reclaimer

http://upload.wikimedia.org/wikipedia/commons/7/72/Krupp_bridge_reclaimer_rtca_kestrel_mine.jpg

Article 51-5-5. Reclaimer roadbed

1. It is preferable to establish such solid roadbed as shown in Photo-74 for large capacity stacker and reclaimer. However, it may finished with crushed stone ballast mat as shown in Photo-73 without piles or rigid foundation in case change of layout of coal yard are expected or reducing construction cost.

Photo- 73: Ballast of reclaimer roadbed

http://southern.railfan.net/ties/1980/80-3/pride3.jpg

Photo- 74: Foundation of reclaimer roadbed

http://www.hokudenkogyo.co.jp/sekitan/case/photo/c04_ph01.jpg

Article 52. Indoor coal storage yard and coal storage silo

Article 52-1. Measure for coal dust

1. There are places where coal dust accumulates in buildings such as the indoor stock yard, coal blending room, transfer building, conveyor gallery, etc. in power plant, it is necessary to recover accumulated dust to prevent fire and explosion due to coal dust. Generally, the equipment such as bag filter or cyclone, etc. which is free of ignition source must be installed.

Article 52-2. Coal dust explosion

1. Three conditions such as dust, ignition source, oxygen must be provided for the dust explosion. Dust explosion is caused by burning airborne dust and going to continue to propagate combustion. If distance between the particles of airborne dust is too open, dust explosion does not occur and propagate combustion. The lowest density which is the explosion can be propagated is called “lower explosion limit”. If the density is too dense, it can not propagate combustion and explode, since there is not enough space for oxygen to combustion. The concentration which has adequate space to maintain combustion is called “upper explosive limit concentration”. Coal dust below 10μm which is generated and accumulated during mining, loading and transportation in underground mines may ignite and cause explosions in gas explosion or mine fire. It is likely to occur in coal which has high volatile matter and less ash content. It is necessary to avoid conditions such as coal dust, oxygen and ignition source as shown in Table-18. In particular, conditions are easily aligned in an airtight vessel like Photo-75, 77, 78 and the measure like a Photo-76 is required.
2.

Table- 18: Explosion criteria of coal

type	Ignition temp. of airborne dust (°C)	Min. ignition energy (mJ)	Lower explosion limit (g/m^3)	Max. explosion pressure (kg/m^2)	Rate of pressure rise		Critical oxygen concentration (%)	Oxygen tolerance (%)
					Average	Max.		
Coal> (Bituminous coal)	610	40	35	3.2	25	56	16	—

Note:

(1) "Limited oxygen concentration" means the critical oxygen concentration to prevent ignition of air-bone dust due to electric spark.

(2) "Allowable oxygen concentration" means the maximum allowable oxygen concentration to prevent dust explosion.

(3) Dust sample must be less than 200 meshes.

(4) "—" indicates that no measurement result.

http://www4.ocn.ne.jp/~katonet/kagaku/bakugen2.htm

Photo- 75: Coal dust explosion

http://www.jsonline.com/multimedia/photos/38983709.html#id_14991494

Photo- 76: Explosion proof bag dust collector

http://i01.i.aliimg.com/photo/v0/440307345/LPF_M_series_of_coal_mill_dust.jpg

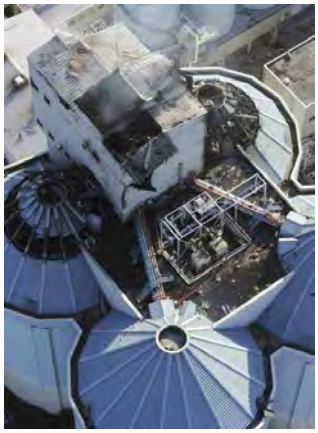


Photo- 77: Coal dust explosion of silo

http://photo.sankei.jp.msn.com/highlight/data/2011/11/25/9fire/

Photo- 78: Coal dust explosion of silo

http://photo.sankei.jp.msn.com/highlight/data/2011/11/25/8fire/

Article 52-3. Gas explosion

1. The flammable natural gas is classified into the structural gas, the coal field gas which is produced in coalfield, the dissolved gas which was dissolved in groundwater, etc. The natural gas that is produced in the area of primarily coal field mines is called “coal seam gas”. Methane gas is the main composition of the coal seam gas, since methane accumulates in many of the coal layers. Methane is generated as a byproduct in the process of mining.

   The coal seam gas generates when digging tunnels where containing large amounts of methane. Methane itself is harmless to humans; emission of large amount of methane in enclosed spaces underground and lack of oxygen cause suffocate death. If the toxic gas such as carbon monoxide is included at the same time, it may issue an addict. Gas explosion often occurs immediately after the gas emission, since it is emitted at a burst.

2. Flammable Limit

   The combustible mixture is produced within the limited range of gas concentration in the air as shown in Table-19. This range is unique to each gas and vapor, the upper limit is called upper explosive limit (UEL) and the lower limit is called lower explosive limit (LEL).

   At level below the LEL is insufficient explosive gas (mixture is lean (Lean)), at the level above the UEL is insufficient oxygen to the mixture (mixture is rich (Rich)). Accordingly, the range of each combustible gas is between the LEL and UEL of gas mixture. The mixture can not be burn outside this range. The limit of some combustible mixture is shown in Table-20. The data is related to gas and steam under standard pressure and temperature. The combustible range is usually expanding depending on the increase of pressure, temperature and oxygen content.

   Typically, a gas leak to the surrounding area from plants does not occur, which may occur in o only low background levers even in the worst case. Therefore, the detection system and early warning system is only required to detect gas at 0% to LEL It is necessary to shut down plant or purge the site before concentration reach to the LEL. In fact, usually adequate measures to shutdown plant and purge site when a concentration reached less than 50% of the LEL value is taken in order to ensure sufficient safe.

   However, the location where it was closed or no ventilation may occasionally reach concentration above the UEL. Therefore, it is necessary to pay attention to opening and closing of hatches and doors at study phase, because it is possible to dilute the combustible mixture or a mixture of toxic by entry of air.

   BS EN 61779-1:2000 Electrical apparatus for the detection and measurement of flammable gases -Part 1: General requirements and test methods

Table- 19: Data for flammable gases

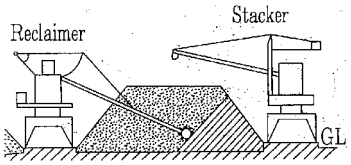
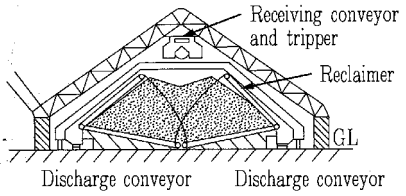
Flammable gas	Chemical formula	Molecular weight	Flash point	Ignition point	Explosive limit (in air) (volume%)		Explosive limit (mg/l)	
					Lower	Upper	Lower	Upper
Carbon monoxide	CO	28.0	Gas	651	12.5	74	146	860
Methane	CH_4	16.0	Gas	537	5.3	14	35	93

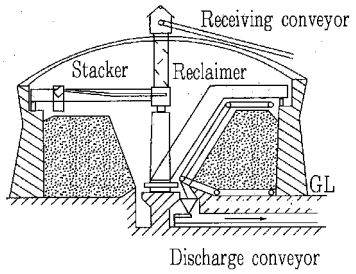
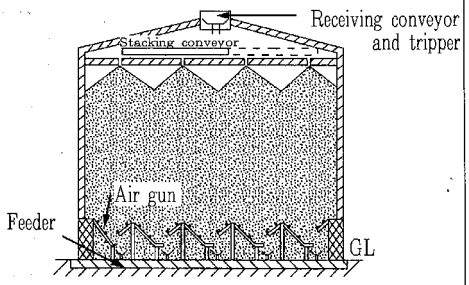
http://www.honeywellanalytics.com/ja-JP/gasdetection/Pages/GasHazards.aspx

Article 52-4-1. General of indoor coal storage yard

1. The indoor coal storage is adored for the storage of coal which contains iron-sulfur, coal which is significantly diminishing calorific value or gas generation, coal which tends to absorb moisture and in the place where it is necessary to consider for the winter snow and freezing. In reentry, it is employed when the space is constrained and as a measure of noise protection. In addition to the high construction cost, the attentions to the measures for spontaneous combustion, coal dust explosion, human safety, etc. are necessary compared with the outdoor coal storage. It is necessary to monitor continuously by installed thermometer and gas concentration analyzer (methane, carbon monoxide, oxygen, etc.). The comparison of features between the outdoor coal storage and various indoor coal storage methods in Table-20.

Table- 20: Comparison of typical coal storage systems

Item \ Type	Outdoor type	Gable roof type
Shape		
Storage of coal by type	Allowed	
Coal that stops up the conveyor	No possibility	
Large-capacity coal storage	Suitable	
Track record	Plenty of track records	Frequently found in Europe; found in Japan, too.
Maintenance	Easy	
Measures against coal dust explosion	Not necessary	Necessary (dust collection)
Measures against coal dust dispersion	Necessary	Not necessary
Site area ratio	100	100

Item \ Type	Dome type	Silo type
Shape		
Storage of coal by type	Difficult	Not possible
Coal that stops up the conveyor	No possibility	Possible but measures can be taken
Large-capacity coal storage	Suitable	100,000 tons／unit (planned)
Track record	Not many; found in Japan, too.	Many recent track records
Maintenance and servicing	Slightly difficult	Easy
Measures against coal dust explosion	Necessary (dust collection)	
Measures against coal dust dispersion	Not necessary	
Site area ratio	70	35

[Source: Figures only from Thermal Power Handbook, Denryoku Shinpou-Sha (1992)]
[Source: Thermal and Nuclear Power, Vol.55/No.569, Introduction Lecture: Fuel Facilities (February 2004)]

Article 52-4-2. Span roof type storage yard

1. Photo-79 is the barrel roof or triangle roof type indoor storage yard which is aimed measures prevention of moisture absorption and dust. Coal is unloaded by the tripper on the conveyor running in the longitudinal direction under the span roof as shown in Photo-80. Discharge is performed to both side conveyors by bridge-type chain reclaimer or dropping into the underground hopper by bulldozer as well as outdoor storage and sending to coal bunker. The facility is simple and relatively easy to maintain, however, the segregation of coal particle size is more than other system.
   In simplified system both end open as shown in Photo-81, 82, the bulldozer is mainly used for the handling of coal.

Photo- 79: Gable type indoor coal storage yard

http://www.jpde.co.jp/business/gallery/gallery10.html

Photo- 80: Gable type indoor coal storage yard

http://www.jpde.co.jp/business/gallery/gallery10.html

Photo- 81: Gable type indoor coal storage yard

http://www.treehugger.com/20110705-powdered-coal-storage.jpg

Photo- 82: Gable type indoor coal storage yard

http://www.spcsb.com/gallery.html

Article 52-4-3. Dome type storage yard

1. This type is the all-weather type coal yard as shown in Photo-83, 85; the main purpose is the saving of land and has positioning between outdoor storage and silo storage. Coal is transported to the dome center of roof and coal is arranged to any point by mobile rotated stacker around center as shown in Photo-84, 86. The discharge is performed by turning chain reclaimer from any point, discharging to underground hopper and sending to coal bunker by conveyor. However, configuration of equipment becomes a little complicated and it is difficult to maintain.

Photo- 83: Dome type indoor coal storage yard

http://www.jpde.co.jp/business/gallery/gallery10.html

Photo- 84: Stacker & reclaimer

http://www.jpde.co.jp/business/gallery/gallery10.html

Photo- 85: Dome type indoor coal storage yard

http://www.cnspaceframe.com/cnxzlf/products/big/201007/Datang_Coal_storage_space_frame_structure_297_0_1280474377.jpgl

Photo- 86: Stacker & reclaimer

http://www.shinco-industrial-equipment.com/images/bedeschi/Secil-Coal%20circular%20storage.jpgD

Article 52-4-4. Silo type storage yard

1. Coal is transported to the tripper on the roof of the silo center and arranged by mobile stacker. Discharge is performed by turning feeder, discharging conveyor and sending to coal bunker. It can be solid structure in shockproof, anti-clogging measure for hopper is required. This coal system is adopted depending on the land circumstances and type of coal appropriately. Photo-87 and Photo-88 shows the example of coal silo and coal bin.

Photo- 87: Coal storage silo

http://www.jpde.co.jp/business/gallery/gallery10.html

Photo- 88: Coal storage bin

http://www.best-b2b.com/userimg/973/988-1/steel-silo-with-cone-bottom-155.jpg

Article 53. Coal discharge facility

1. Coal Discharge Facility

   The discharging method is also associated with coal storage system; Table-21 is considered such a combination.

Table- 21: Combination of withdrawal method and discharge method of coal

Receiving	Discharge
(1) Tripper, bulldozer, etc.	Bulldozer, etc.
(2) Stacker	Reclaimer

In addition to the above, there are other ways and each of these mixed systems, the appropriate method must be selected taking into account the amount of handling coal, the amount of coal storage, storage system, the shape and topography of stock yard as well as the method of coal storage. The receiving and storage facility for coal which is assumed by marine transportation and outdoor stock yard is shown in Fig-11.

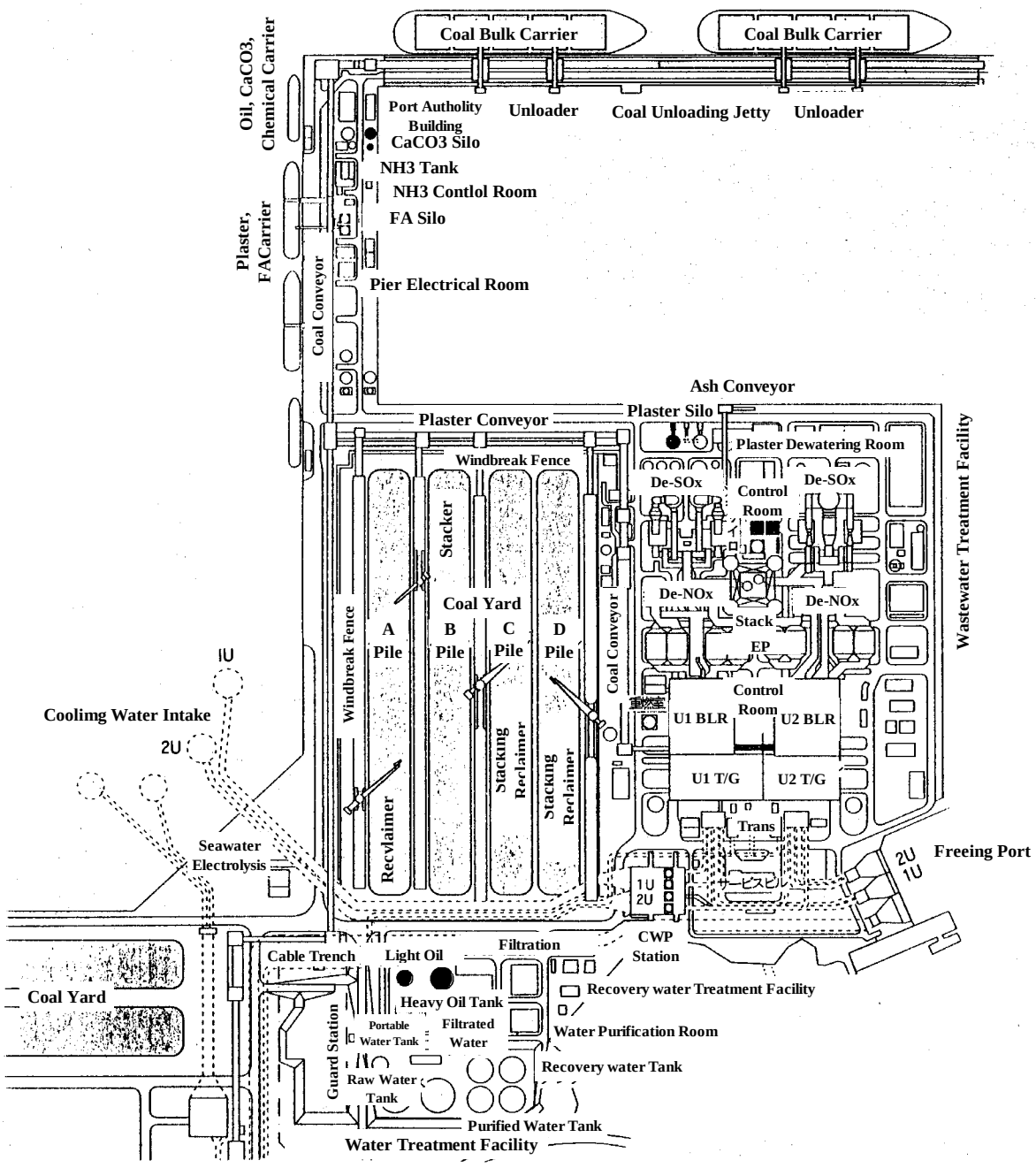


Fig- 11: Layout of coal receiving and storage facility (outdoor type)

Reference: P-145 of Journal (No.516: Sept. 1999): TENPES

The receiving and storage facility for coal which is assumed by marine transportation and indoor stock yard is shown in Fig-12.

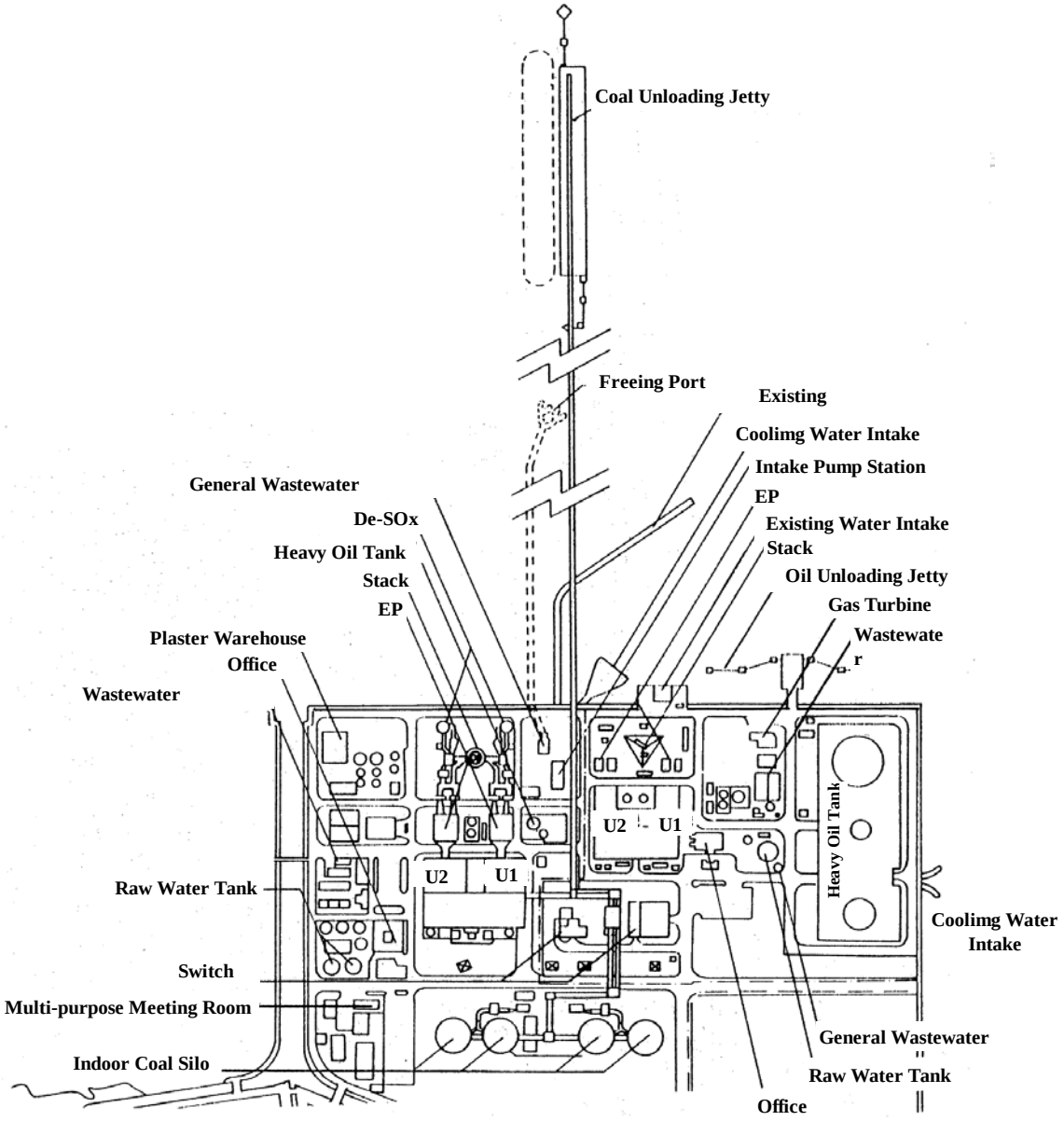


Fig- 12: Layout of coal receiving and storage facility (indoor type)

Reference: P-146 of Journal (No.516: Sept. 1999): TENPES

Article 53-4-1. Bulldozer

1. The bulldozer is applied to the coal storage method as shown in Photo-81, 82 of Article52-4-1 and discharge is performed by same bulldozer or scraper in the same stock yard. Coal will be sent to bunker by belt conveyor below hopper after bringing into a coal hopper by bulldozer or scraper. It is difficult to consolidated automated transportation from receiving to stock yard discharging to bunker, while the equipment is simplified. Grading, compaction, upsetting, falling into dropping, etc. must be performed by bulldozer which driver operates.

Article 53-4-2. Type of discharge machine

1. In case of an outdoor type, coal is discharged via a conveyor from a bulldozer or reclaimer, in the case of an indoor silo type, a discharge machine as shown Photo-87, 88, 89, 90, Fig-13 and 14 takes coal out of the bottom of a silo, with the coal being discharged via the conveyor on the discharge machine side.

Photo- 89: Rotary discharge machine (RDM)

http://www.mitsuimiike.co.jp/product/transport/indoor/

Photo- 90: Slewing screw type (RRR)

http://www.mitsuimiike.co.jp/product/transport/indoor/

Photo- 91: Centrex type discharge machine

http://www.mitsuimiike.co.jp/product/transport/indoor/

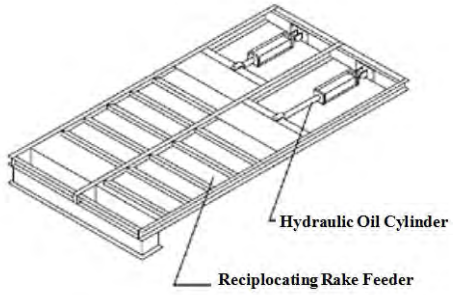


Fig- 13: Reciprocating rake feeder

http://www.mitsuimiike.co.jp/product/transport/indoor/

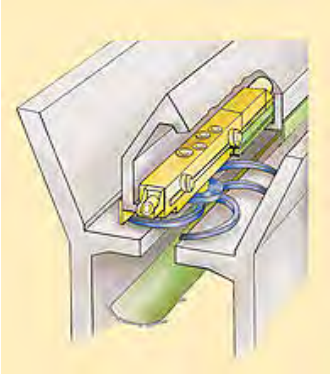


Fig- 14: BDM bunker discharge machine

http://www.mhc-engineering.de/49/?L=1

Photo- 92: BDM bunker discharge machine

http://www.mhc-engineering.de/49/?L=1

Article 53-4-3. Screen

1. These are usually used in combination, provided prior to store coal in the coal yard or send coal to coal bunker. It is necessary to make particle size to less than 50mm by the screen as shown in Photo-91, 92 and to be able to send directly to the coal mill depending on the performance of coal mill and it separates more than a grain, to remove the foreign body and define gratuity by crusher.

Photo- 93: Vibrating screen (1)

http://image.made-in-china.com/2f0j00neytWVzqCvrf/Coal-Screen-Vibrator-YA-.jpg

Photo- 94: Vibrating screen (2)

http://image.made-in-china.com/2f0j00bBeTgkCdAcpI/Vibrating-Screen-for-Coal.jpg

Article 53-4-4. Magnet separator

1. This is provided in the head of coal transport conveyor to remove the iron mixed in coal and suck irons in the coal by hanging magnet as shown in Fig-15 and Photo-93. There are various kinds, and it starts extraction to move in conjunction with the conveyor starts, stops sucking the shingles on the conveyor moving with a mobile device or lifting device. If the conveyor stops, it moves above receiving box side and fall absorbed ions into the box after energizing.

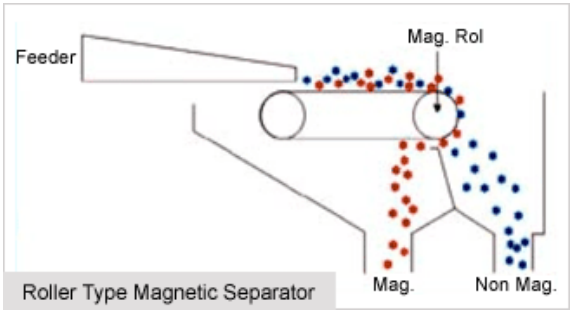


Fig- 15: Magnet separator

http://www.themagnetguide.com/gifs/roller-magnetic-separator.gif

Photo- 95: Magnet separator

http://www.spiewak.pl/separators.html

Article 53-4-5. Coal weigher

1. Weigher

   The weigher is necessary for commerce and inventory management and will be provided on each receiving system and discharge system. There is type as follows depending on the form of

transportation of coal.

(1) Wagon scale or truck scale

The platform scale is provided measuring coal to be able to weight trucks loaded with coal left. It is possible to know individual weight by measuring the total weight and the empty weight, knowing the net carrying amount of coal. Accuracy is about ±0.05%.

(2) Hopper scale

The weighing hopper is provided above and below the bunker. Coal is projected from upper bunker to hopper; the gate is closed automatically when weight reaches the regulation and discharges into the lower bunker after the bottom of hopper gate is open. Wile this operation is repeated, the amount of coal is accumulated. This scale is suitable for continuous weighing but is taken place in order to use the head. Accuracy is about ±0.2～0.5%.

(3) Conveyor scale

This is installed in horizontal or inclined conveyor within 15 degree as shown in Photo-96, 97, weighing automatically during the transportation of coal and shows accumulation. Merric type is the main. Merric type displays accumulation continuously according to the rotational speed of the rotating disc which is proportional to instantaneous load of coal on the belt. An accuracy of the conveyor scale is about ±0.05%. It has been used to weigh receiving and discharge coal, since it has high efficiency and less failure.

Photo- 96: Belt scale (1)

http://www.taihengsh.com/PicUpFile/20105816195836932.gif

Photo- 97: Belt scale (2)

http://magnets4industry.com/assets/images/Weigh_Shark_Conveyor_Belt_Scale__Conveyor_Belt_Scales_by_Direct_Line_Supply__Belt_Scales_for_all_conveyors__belt_conveyor_scales.jpg

Article 53-4-6. Coal blending

1. Generally, it is necessary to use coals after blending for the purpose of adjusting the amount of calorific value or sulfur content, since many kinds of coal are accepted for the thermal power plant. Typical coal blending methods are as follows, although there are many methods by the type, amount and handling.

(1) Blending by bulldozer

This is the method to drop coal to underground hopper for blending by bulldozers, it will be finished blending while discharging from hopper to discharge conveyor below hopper. It is sufficient to achieve the purpose in some cases, since it is not required special equipment, although the accuracy is very low.

(2) Hopper blending

This is the method of coal blending on a conveyor belt by means of reserve in several hoppers by the strain of coal, cutting out required amount from constant discharger below hopper and blending. This method can be automated the coal blending in high accuracy if once it has set the coal blending ratio, however, a disadvantage is the high cost of equipment and maintenance.

(3) Blending on conveyor

There is a method which two or more travelling reclaimers cutting out separately the appropriate amount from the coal pile stacked by quality and brand and blending on the downstream belt conveyor, a method which wheel type reclaimer or scraper type reclaimer cutting off coal from the coal pile that is stacked quality and brand is formed a uniform cross-sections mixed breed by stacker and blending. These methods have less equipment cost and maintenance cost in the viewpoint of overall and are adopted from easy automatic operation, although these methods are complicated for control compared with the hopper blending.

Article 53-4-7. Sampling equipment

1. This is the equipment to collect coal samples and is provided at the connecting chute of usual conveyor belt in order to check the quality of coal being accepted or discharging. Samples collected in the system acceptance on the transactions, the systematic withdrawal is also important to provide data on their boiler combustion control, sampling handling and collection of sampling lines between the amounts collected in accordance with certain criteria. Especially, quality checking is often defined by the international Standard or Japanese Standard. The collected sample is sent to the packer after reduction and is packed in a polyethylene bag automatically, sealed, stored in a container ensuring moisture. The actions up to be stored in a container can be performed automatically and unattended. Two systems are illustrated in Fig-16 as sample.

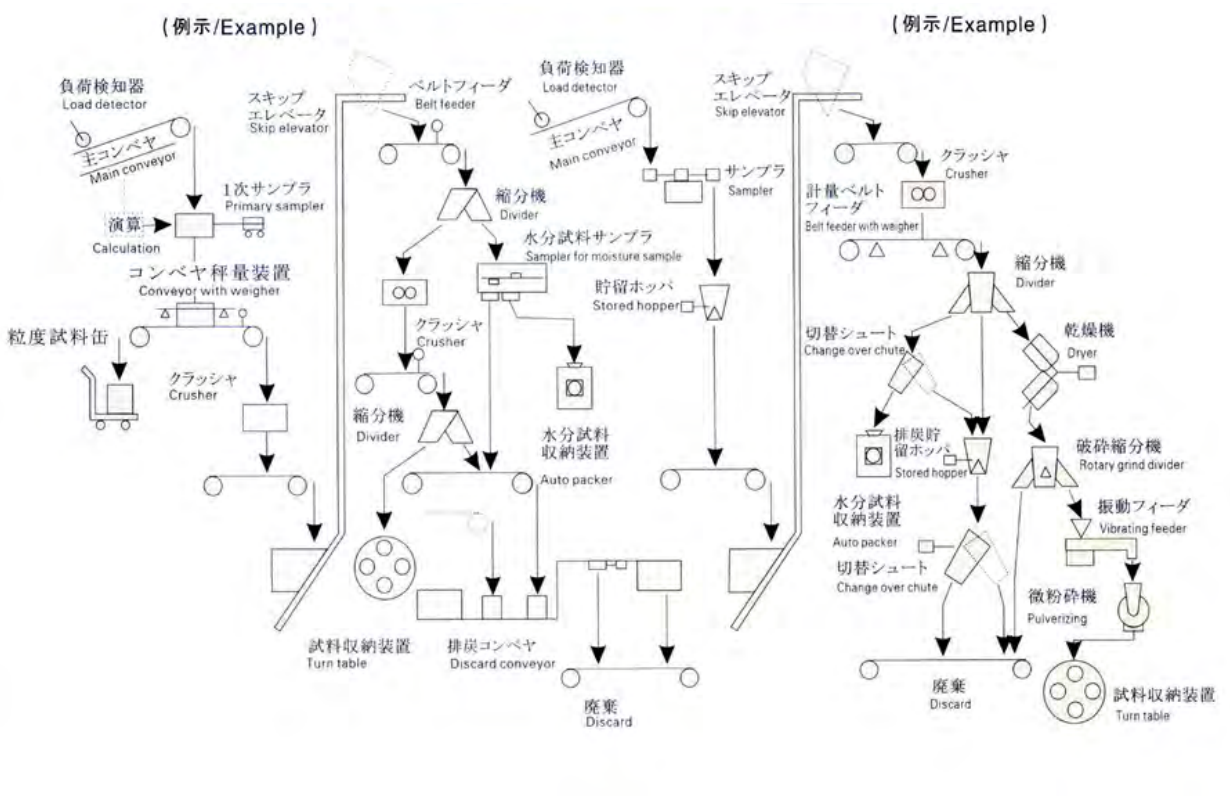


Fig- 16: Coal sampling equipment

http://www.kyokutohkousan.co.jp/category_img/sampling/l_c_s_e.jpg

Article 54. Coal Conveyor, tripper and shuttle conveyor

Article 54-1. Common requirement for belt conveyor

1. Introduction

It is necessary to consider the handling capacity, amount of stock in the stock yard, shape of stock yard and topography when selecting the equipment to be used for coal storage. The coal receiving and discharging have been performed effectively by the combination of stackers and reclaimers traveling on the rail in the large capacity power plant.

Belt conveyors are used to transport between different devices by connecting unloading wharf, car dumper, coal yard and bunker. Transportation from unloading to coal yard is performed by conveyors combination provided mainly low on the ground. The coal storage is performed by the center conveyor with tripper in case of loading by tripper, transporting coal on the belt conveyor provided low on the ground to the stacker incase of the stacker. The underground conveyor which is installed below coal hopper across the coal yard and inclined conveyor goes out to the ground in case applying bulldozers and scrapers for the discharge of coal. The drainage for spring water and rain water to penetrate into tunnel and ventilation equipment and dust collector is provided in case of the underground conveyor. The maximum slope angle and speed must be determined in considering nature of coal, particle size and various other elements of coal to transport. The inclination is around

12~17 degree. The speed is often 200~300m/min. The transportation capacity is around 400~1,000t/h and is 6,000t.h maximum.

The typical configuration is shown in Fig-17, Photo-98, 99, It is driven by head pulley.

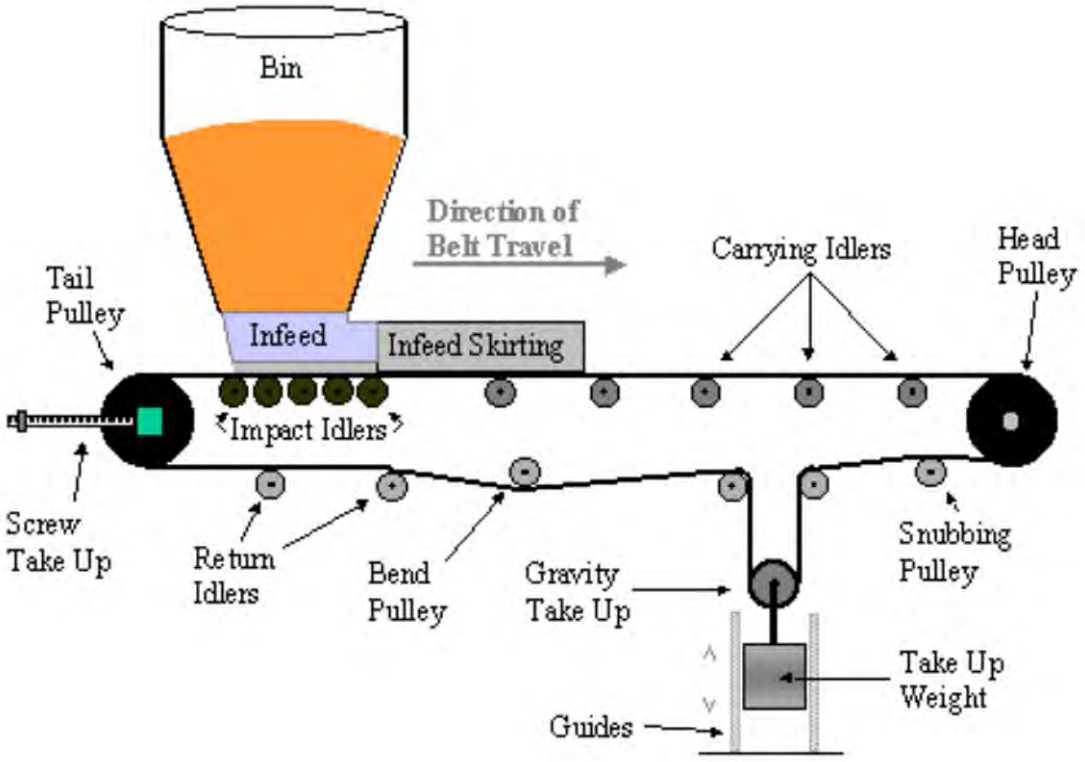


Fig- 17: Typical construction of belt conveyor

http://www.powderandbulk.com/pb_services/ask_joe_archive/selecting_and_installing_conveyor_belt_scales.htm

Photo- 98: Coal conveyor (1)

http://www.protectowire.com/images/applications/conveyor/coal-baltimore-lg.jpg

Photo- 99: Coal conveyor (2)

http://emcon-systems.com/images/11g.jpg

2. Belt conveyor

2.1 **"Driver equipment and main pulley"** stipulated in the design technical regulation Article 54-2-(1) are the equipments which is necessary for the drive such as the pulley, high tension snap pulley and reduction gear, etc. and the main pulley such as the head pulley and tail pulley.

2.2 **"Firefighting equipment"** stipulated in the design technical regulation Article54-1-(4) is the construction which meets the following requirements. However, if the conveyor belt with motor output less than 20kW, this must not apply.

(1) The range of structural fire protection must be more than 1.5m across the windward side of facility and at least 15m downwind side. However, the area blocked by fire doors may be treated as fire permissible area if it has the structure which is blocked by fire doors.

(2) The method installing automatic sprinkler system which initiates at least 30ℓ/min per square meter around the facility and a discharge pressure of 0.15MPa and more.

2.3 **"Emergence stop equipment"** stipulated in the design technical regulation Article-54-2-(3) is the device to artificially stop the conveyor belt when an error is found.

2.4 **"Back stop device"** stipulated in the design technical regulation Article54-2-(3) is the device to prevent the reversal of the belt when there is problem on power such as power outage or other abnormality.

2.5 **"Other safety device"** stipulated in the design technical regulation Article54-2-(3) is the slip detection device (to stop belt conveyor automatically when belt slip), bias detector (to stop belt conveyor automatically when detecting meander or bias of belt), chute blocking detector (to stop conveyor automatically when detecting blocking of chute), overload sensing device (to stop conveyor automatically when detecting overload), etc.

2.6 **"Installed appropriately"** stipulated in the design technical regulation Article54-1-(4) means that the circumstances set forth as below;

(1) The fire hydrant must be provided in the place within 100m from the starting of end point of conveyor.

(2) The discharge equipment must be equipped in the place where it can be connected to the hydrant quickly.

(3) "Where it can be connected quickly" defined in (2) means the place within every 200m from the starting of end point of conveyor (including the place within 20m from the closest fire hydrant to conveyor driver in the windward side).

3. General provision of conveyor

3.1 Purpose

This guideline provides considerations for design, manufacturing, installation and usage of conveyor and other associated equipment in order to prevent accidents due to contact or falling of loads.

3.1.1 Design and manufacturing

(1) The design of conveyor must be noted following items;

1) To have sufficient strength and stability.
2) To prevent load slip.
3) To prevent load falling off at the point where loading, unloading and transportation.

(2) The vertical or inclined conveyor must be provided a device to prevent over run or reverse run of load or conveyor due to blackout or voltage drop.
(3) The conveyor which has the relief device by an electrical or manual, telescopic equipment, turning equipment and lifting equipment must be provided a device to secure them.
(4) The cover or enclosure must be provided at the power transmission portion of the conveyor.
(5) The cover and enclosure must be provided at the belt, pulley, roller, chain, chain rail, screw and other place where worker might be trapped t or caught.
(6) The switches for starting or stopping of conveyor must be clearly visible and what can be readily manipulated and it must not start suddenly due to contact and vibration, etc.
(7) The conveyor must be provided lubrication oil feed system which can not be closed to the dangerous moving parts.
(8) The conveyor which loading or unloading by human must have appropriate height, width and speed for workers performing these tasks.
(9) The force required for the operation of the devices by manual must be 20kg or less.

3.1.2 Installation

(1) The conveyor must be arranged without gap that may pose a risk to workers between moving parts, stationary parts and other things.
(2) The floor for platform and cabin which is mounted on conveyor must be level.
(3) The platform walkway stipulated in (2) must be 60cm width, 90cm height and with cross rail. However, the contact portions of the pillars of sidewall construction must be capable to increase its width 40cm or more.
(4) The ladder must not be used instead of lamps and stairs. However, if the workplace is unavoidable, a ladder can be used pursuant to the following.

1) The step must be provided at intervals of between 25cmand 35cm and regular intervals.

2) If there is an obstacle to the front of the ladder, the gap between steps and such obstacle must be 60cm and more. However. The gap between steps can be 40cm and more when there is partial obstacle.
3) If there is an obstacle behind the ladder, the gap between steps and such obstacles must be 20cm and more.
4) The back belt or fence must be provided in the part where exceeds 2.5m, if the angle of ladder is exceeds 70 degree and the height is exceeds 5m.
5) The landing must be provided within each 10m, if the length of the ladder exceeds 15m.

(5) The stairs fixed ladders must be provided for the control room which is provided in the position beyond 15m height from ground floor or outside floor.
(6) The platform which is stipulated in (2) and flower of walkway must be no danger of stumbling and slipping.
(7) The measures to remove and protect the sharp edges and projections of buildings and conveyor, etc. must be taken to prevent such danger.
(8) The bridge with handrail which is height 90cm and more and has cross rail handrail must be provided the point where workers cross conveyor.
(9) The passage must be clearly indicated and be safe by protection of dangerous place.
(10) The fence or handrail must be provided around the floor opening, if conveyor penetrates through the floor or pit.
(11) The facility to prevent the falling of the load must be provided for the conveyor passing above the working floor or passage.
(12) The interlock to stop the supply for other stopped or full loaded conveyor must be provided.
(13) The electrical device which is used in the risk of explosion, the location of the conveyor to transport flammable dust or explosion hazardous area must be the explosion-proof.
(14) The continuous emergency stop switch along the conveyor and emergency switch in key point of conveyor must be provided.
(15) The warning device to announce the starting of conveyor must be provided.
(16) The side walks, handrails, stairs, ladders, etc. must be provided before work begins.
(17) The instruction manual, etc. must be provided at the place where the location of the conveyor.

3.2 Belt conveyor

3.2.1 Design and manufacturing

(1) The width of the belt must be sufficient to meet the type of load and the amount of transportation and a device to load on center of the belt, if necessary.
(2) The device to prevent the risk from a falling or slipping of load must be provided for the conveyor which may have risk due to stopping of operation and uneven loading (limited to the inclined conveyor when the bulk material is loaded).

(3) It cannot be provided the backstop device when the total load capacity is less than 500kg on the inclined portion of the belt conveyor, a single load does not exceed 30kg; there is no fare of running over or reverse of bucket.

(4) The belt cleaner or pulley scraper must be provided when transporting load tends to adhere to the belt or pulleys.

3.2.2 Installation

(1) The cover or enclosure must be provided at the opening of the hopper and chute that may pose a risk to the workers.

(2) It is preferable to provide an inspection opening on the large hopper and chute.

(3) The facility to prevent the risk by falling objects must be provided, if the object attached to the return belt may pose a risk to workers attaché.

(4) The cover and enclosure must be provided at the take-up that may pose a risk to the workers. In the case of gravity type take-up, the cover or enclosure to prevent workers from entering directly beneath the weight must be provided, or the equipment to prevent falling of weight must be provided.

3.3 Shuttle conveyor, etc.

3.3.1 Design and manufacturing

(1) The shuttle conveyor, etc. (shuttle conveyor, scraper, hopper, feeder, associated equipment to belt conveyor and which can be run) must be minimize the protrusion.

(2) The operation cabin for shuttle conveyor must have the structure that it is no contact with outside facilities other than said shuttle conveyor.

(3) The device for limiting the travel range must be provided for shuttle conveyor.

(4) The alarm device to notice to start running must be provided in case the shuttle conveyor with running speed is exceeding 0.1m/s.

(5) The locking device must be provided for scrapers, hoppers, feeders which are associated to conveyor and may be traveling.

3.3.2 Installation

The cover for the shuttle conveyor, etc. that may come into contact workers must be provided.

3.4 Freight conveyor and flow conveyor

3.4.1 Design and manufacturing

(1) The access door must be provided in the place where the worker can check easily.

(2) The flow conveyor which transport flammable dust explosion hazard must have safety construction to prevent explosion by explosion door.

(3) The flow conveyor must have the construction that can discharge the remaining ones of the flow inside the conveyor housing.

3.4.2 Installation

(1) The control device of gate must be installed in the location where workers can easily operated and can be seen the flow of load.

(2) The cover or enclosure must be provided at the opening of the hopper and chute that may pose a risk to the workers.

(3) It is preferable to provide an inspection opening at the large and chute.

(4) The casing of flow conveyor must be installed by effective manner depending on the type of load.

3.5 Screw conveyor

3.5.1 Design and manufacturing

(1) The cover on the trough with built screw of horizontal screw conveyor must be covered except for the inlet and outlet of the load.

(2) The inlet and outlet opening for the load must have the structure without contacting workers with the screw and must be provided the fence to the inlet and outlet of the said load.

(3) The lubricating apparatus for the intermediate shaft bearing must have the structure which can be rubricated from the outside of trough.

(4) The screw conveyor for the transportation of flammable or dust explosion hazard must have a safety structure by means of providing explosion door.

3.5.2 Installation

The cover on the trough with built screw and those that workers may cross over must be capable to support a load of 150kg and more.

3.6 Bucket elevator

3.6.1 Design and manufacturing

(1) The door for cleaning must be provided at the elevator boots. In addition, said door must be easy to clean inside and must have arrangement and structure that are not inadvertently opened.

(2) The casing of bucket elevator must be closed when transporting a load that generates dust. In addition, the dust collector must be provided for bucket elevator, if needed.

(3) It cannot be provided the backstop device when the total load capacity is less than 300kg, the vertical shaft center distance of the pulley or sprocket center is less than 5m; there is no fare of running over or reverse of bucket.

3.6.2 Installation

(1) Cover or enclosure must be provided that could pose a risk to workers through contact with moving parts of an open bucket elevator. In addition, where the load which may fall from an open bucket elevator is to be provided a facility to prevent risk from falling load.

(2) The cover and enclosure must be provided at the take-up that may pose a risk to the workers. In the case of gravity type take-up, the cover or enclosure to prevent workers from entering directly beneath the weight must be provided, or the equipment to prevent falling of weight must be provided.

3.6.3 Use

(1) The loading to bucket elevator must be capable to perform by suitable feeder or chute.

(2) The take-up equipment must be adjustable so that the proper distance between bottom of boot and the lowest stop position the bucket.

4. Miscellaneous provisions

The conveyor must be displayed the following items in the visible place.

1) Name of manufacturer
2) Date of manufacture
3) Maximum load capacity and maximum haul per unit time
4) Transferring velocity
5) Type of load

5. Safety device for conveyor

(1) Emergency stop device

The emergency stop device as shown in Photo-100, 101, 102 and Fig-18 has an extension spring, which maintains constant tension on the pull cable. The operating handle is held in the center vertical position with the internal switch in a normally closed condition. If the cable is pulled or the cable breaks, the handle rotates to release the switch lever. In this way the alarm signal is generated for both conditions: pull or break. The operating handle must then be manually reset back to the center position after the problem has been corrected

Photo- 100: Emergency stop rope (1)

http://www.miningphoto.com/show/1726/detail

Photo- 101: Emergency stop rope (2)

http://www.miningphoto.com/show/1646/detail

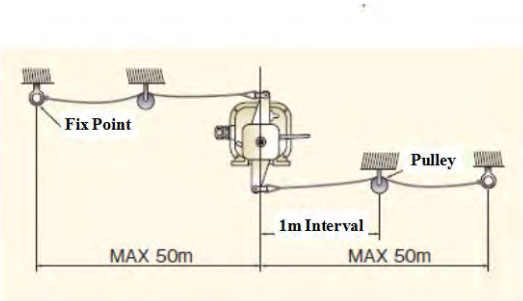


Fig- 18: Emergency stop rope

http://www.kansai-automation.co.jp/products/pdf/PC-062-1001J.pdf

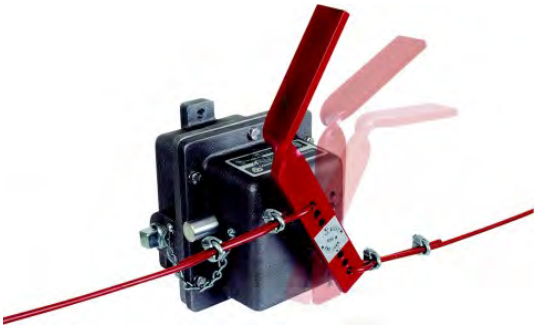


Photo- 102: Emergency stop rope

http://www.wastewaterpr.com/releases/view/470/Safety-Stop-Switch-Saves-Lives

(2) Backstop device

When stopping the inclined or vertical conveyor in emergency while a conveyance riding, it is dangerous due to the reversing by the weight of conveyance. It is necessary backstop in order to prevent accidents caused by reversal. For example, the ratchet wheel type, roller type, cam-clutch type and electromagnetic brake type, etc. are available. Cam-clutch has structure which rotated in only one direction and can be prevented reversal by fixing the torque arm to the body. It is composed of roller, cam and oil seals, etc. and is filled with lubrication oil.

The overrunning clutches as shown in Fig-19 and 20 are used on head shaft of conveyor system for giving an instantaneous switching from primary drive to stand by drive for reducing down time. In case of mounting, these clutches between conveyor and drive will offer us automatic engaging and disengaging when we are switching from one drive to other.

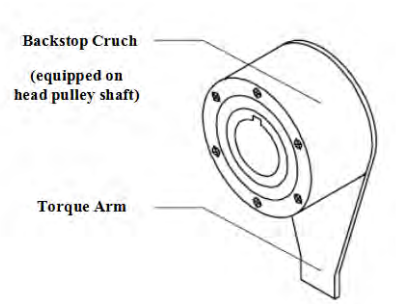


Fig- 19: Backstop crutch

http://www.yoshino-rubber.co.jp/pages/information_pdf/ygk-15.pdf

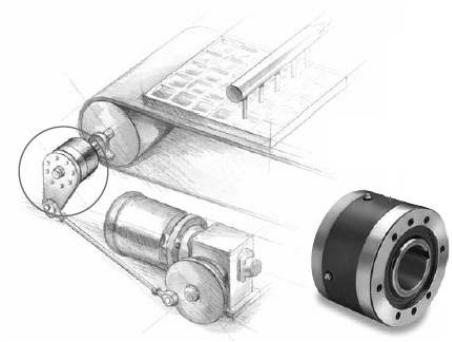


Fig- 20: Backstop crutch

http://www.betp.net/2011/05/applications-of-clutches/

(3) Belt Slip Detector

Belt slip is the loss in transmission of tension from the drive pulley(s) to the belt cover and can destroy a belt or drive pulley, causing a fire hazard.

With the modern high-friction ceramic lagging of drive pulleys, the lagging itself may be destroyed depending on its type, or the belt cover completely stripped in localized areas. Belt slip protection includes a belt drive speed sensor that compares the measured belt speed with the belt signature or specified design speed. Large conveyors with long ramp times require comparative slip detection during ramping similar to the slip protection applied to variable speed conveyors.

For constant speed belts this normally consists of a slip switch with a set point that trips the conveyor drive when the belt speed is below 80 percent of full speed. In order to prevent controller confusion, the belt slip switch is bypassed during starting and stopping and this is usually incorporated in the system PLC programming.

Belt slip in variable speed conveyors consists of a speed sensor that measures belt speed and compares it with the speed reference sent to the drive system. When the belt speed drops below 80 percent of the set speed, the drive is tripped. This type of belt slip is active during starting, running, and stopping. In multiple pulley adjacent drives, tachometers are sometimes provided for each drive motor. The tachometer signals are compared to the normalized belt speed and sense slippage on any one of the multiple drive pulleys.

A method to adjust and test belt slip is normally an integral part of the belt control system. Slip detectors as shown in Photo-101, 102 are often installed at other locations along the line of the belt, particularly at the tail pulley. In the event of the belt breaking for any reason, the tail pulley is usually the first to stop rotating. The take-up pulley is another favored location for slip detection. Slip detection at these locations not only indicate broken belting, but also indicate problems in the

chute and loading onto the conveyor.

Photo- 103: Slip detecting device (1)

http://www.matusima.co.jp/fileadmin/home/img/product/pdf/conbeya08-2.pdf

Photo- 104: Slip detecting device (2)

http://www.matusima.co.jp/fileadmin/home/img/product/pdf/conbeya08-2.pdf

(4) Belt Alignment Switch

It is important that the belt stays aligned with the drive pulleys and the carrying and return idlers. Belt alignment sensors are typically positioned along the edges of the conveyor fabric. They are usually located at the discharge and at the loading areas of the conveyor, but can be distributed along the conveyor at intervals, depending on the conveyor route and the requirement.

Belt alignment switches as shown in Fig-21 and Photo-103 are often located on the unsupported section of belting in a horizontal take-up system in order to minimize the damage that misalignment can do in this area. Switches consist of roller switches, limit switches, whisker switches, proximity switches or photoelectric switches. When the edge of the belt trips the alignment switch for a timed period, power to the conveyor is interrupted and the system halts immediately. An adaptation of alignment sensors for large steel cord belts is the continuous measurement of edge displacement, termed „edge tracking'. Edge tracking in steel cable belts provides an indication of tension distribution within the carcass among the support cables. Upon installation, each steel cable belt exhibits an edge-tracking signature for a belt revolution.

A deviation in the edge tracking displacement at a later time would suggest a problem in the belt cable tension distribution. However, these systems are relatively sophisticated and are usually installed only on extremely strategically sensitive conveyor systems.

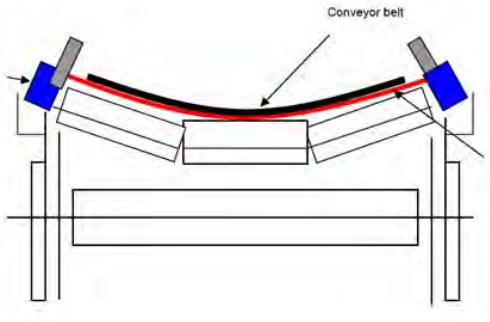


Fig- 21: Belt alignment switch

http://www.go4b.co.uk/uk/belt-conveyor-components.php

Photo- 105: Belt alignment switch

http://www.matusima.co.jp/index.php?id=44

(5) Plugged Chute detector

A plugged chute or blocked chute device provides belt protection at the discharge end of the conveyor into a transfer chute. Blocked flow can result in damage to the moving conveyor. A blocked chute can also cause severe damage to the belt being fed, particularly in the case of a single large lump stuck in the feeding boot and slitting the belt.

Plugged chute switches are used in many configurations depending on the application. Actuation of the plugged chute switch with time delay normally results in the tripping of the conveyor drive.

Typical devices as shown in Fig-22, 23 used are laser, ultrasonic, pressure diaphragm or simple overflow detection. A popular system is to use a mercury switch unit that interrupts the power in the event of a tilt beyond 15° to the vertical. Blocked chute sensors require careful maintenance because they are required to operate in extremely harsh conditions, often in the flow of material and in relatively inaccessible locations.

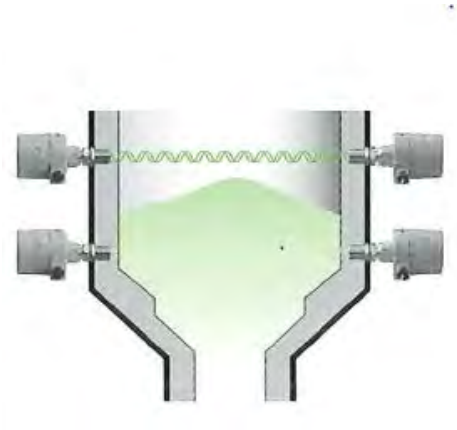


Fig- 22: Micro barer switch

http://www.matusima.co.jp/fileadmin/home/img/product/pdf/switch01-3.pdf

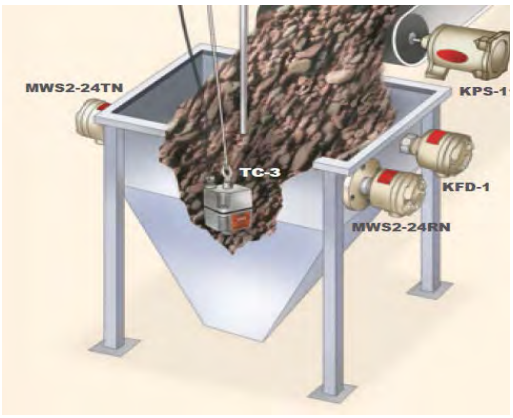


Fig- 23: Plugged chute switch

http://www.kansai-automation.co.jp/products/pdf/PC-062-1001J.pdf

(6) Overload Trip Device

The belt conveyor system is protected from overload via the overload of the electric drive motors. The motor overload indicator can be a simple bi-metallic or melting eutectic alloy or a complex computer-based motor thermal model.

Alternatively, the motor current can be monitored and any significant deviation from the standard operating signature for a pre-determined time will cause a power interruption. A belt loading sail or paddle switch senses a belt overload at a specific point as shown in Photo-104, 105. However, such units must be designed to cater for the largest lump likely to be encountered in order to minimize spurious stops.

On the other hand, if a lump is large enough to activate the paddle switch, it makes operating sense to investigate the lump before it causes consequential damage downstream. Complex belts are sometimes protected from overload by belt weigh scales that measure the belt loading at a given point.

Alternatively, a non-contact belt profile sensor, such as an ultrasonic, radar, laser or video device is used to measure the belt loading depth. Based on an assumed material density, the loading tones per hour can be projected. The actions regarding a single large lump apply in these cases as well. Weigh meter controls are usually coupled to the belt-feeding device, such as a belt, apron or vibrating feeder. The overload sensing signal is then relayed to the feeder controller and the feeder rate is reduced to comply with the requirements of the system.

Of course, unscrupulous operators can bridge, for example, any control and continuous spillage occurrences, despite any other protective measures that are in place. There is often evidence of such bridging or over-riding control of controls found during routine inspections. Other methods of overload control are fusible plugs on fluid couplings and shear pins on flexible couplings. Electronic sensing has largely overtaken the use of mechanical devices and is less easily tampered with.

Photo- 106: Mechanical overload protector

http://www.tsubakimoto.jp/product/class2.html?code=440_1

Photo- 107: Electrical overload protector

http://www.tsubakimoto.jp/product/class2.html?code=440_1

Article 54-2-1. Belt conveyor

1. Flat conveyor

1.1 Outline

This is the device to move belt and transport the bulk conveyance while pulling belt as one ring, which is supporting by rollers arranged at regular intervals, placing the pulley on each end and pulling the belt by rotated driver.

1.2 Features

The type of conveyor belt for bulk conveyance is different depending on the angle of inclination. Table-22 has been divided into 4 types; every type is "black rubber belt conveyor with shape of ship bottom.

Table- 22: Type of conveyor belt

Type	Features	Allowable slope
Flat belt	Remains flat without processing	About 0~18°
Belt with crosspiece (v-piece, center gathering)	Belt with v-shaped crosspiece (projections) on the surface and transport by hooking to them	About18~22°
Fin belt (climber belt)	Belt with fins	About 22~45°
Flex belt	Belt with triangle fins transporting by hooking to them	About45~90°

1.3 Construction

Typical conveyor belt are the black rubber belt and the plastic belt. Structure of black rubber belt and plastic belt are almost similar structure. Conveyor belt has structure that a core (special canvas) is sandwiched between the sides of the rubber cover. Plastic belt is sandwiched between the plastic covers. There are many variations of type of core canvas, cover rubber, cover plastic depending on the strength and use. The stronger the strength of the belt, the thickness of rubber cover, plastic cover is increased and core is overlapped many pieces. That overlapped number of core is called "ply number"; strength rises as the number of belt ply number large.

1.4 Strength

The terms "strong" and "tension" are used to represent the strength of the belt and is expressed in the unit N/mm. It becomes strong belt the greater number. For example, it is expressed "normal belt 315N/mm 3ply-5.0-1.5". It means that the ply number is 3, the upper rubber thickness is 5.0mm, and the bottom rubber thickness is 1.5mm. The expression how to represent the strength of the black rubber belt is same in all manufactures.

1.5 Type of belt

http://www.seibu-g.com/products/pdf/p_1/034-052.pdf

1.6 Trough angle

The belt is bent into the shape ＼＿＿／ (like hull shape) in right and left toward the lateral direction of conveyance to considering spillage. Steel or rollers may be used to form the hull shape. There are three kind of angle to perform the hull shape, it is called “trough angle”. The JIS standard roller is used except in ready-made conveyor in case of hull shape black rubber belt. There are following three kind of angle.

20 degree	: Which has greater specific gravity
30 degree	: Which are general
45 degree	: Which has smaller specific gravity

https://www.justsystem.co.jp/calkingj/images/doboku_pdf/keisansyo.pdf

1.7 Capacity

Transportation capacity of flat belt conveyors is expressed in German standard (DIN) as the following formula. This is almost the same as the Japanese standard.

$$Q = (A1 + A2) \times 3600 \times V = 440 \times V \times (0.9B - 0.05) \times (0.9B - 0.05)$$

Where

Q	: haul	(m^3/h)
B	: belt width	(m)
V	: belt speed	(m/s)
	: trough angle	20 degree
	: angle of repose	20 degree

http://www.forbo-siegling.co.jp/downloads/pdf/SJ-7 TechInfo3.pdf

Article 54-2-2. Pipe conveyor

1. Pipe conveyor

1.1 Outline

There are problems with slipping in of foreign objects or spillage of raw materials ambient pollution depending on the conveyance, because conventional conveyor belt is conveyed in an open state. The pipe conveyor which conveys conveyance wrapped in the pipe shaped belt as shown in Photo-108 has been developed. Dropping dust is reduced and it can be installed the curved conveyor as shown Photo-109.

Photo- 108: Pipe conveyor (1)

http://www.usinenouvelle.com/industry/img/conveying-systems-pipe-conveyors-000127676-4.jpg

Photo- 109: Pipe conveyor (2)

http://www.motridal.it/gfx/pipe_conveyors.jpg

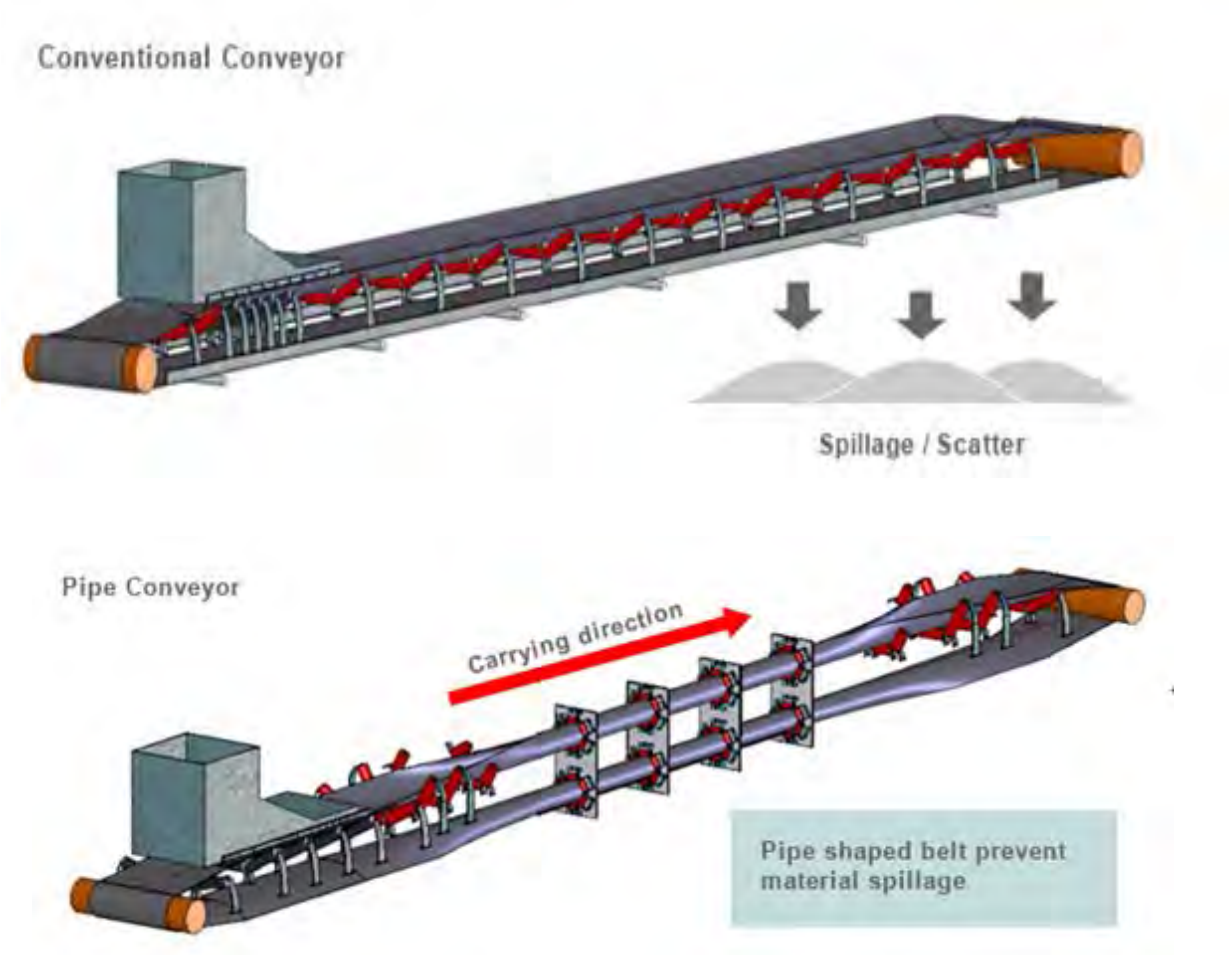


Fig- 24: Typical Construction of pipe conveyor

http://www.bridgestone.com/products/diversified/conveyorbelt/products/pipe_conveyor_belt.html

1.2 Features

1) There is no slipping in of foreign objects and spillage of raw materials, since the conveyance is wrapped by pipe shaped belt.
2) The body frame can be curved, since the belt is pipe shape.

3) There is no contamination of the intermediate rollers, since the return belt can be pipe shape.

4) There is no meandering of the belt.

5) It can be speed up the belt compared with the conventional open type.

are characterized.

Article 54-2-3. Air floating conveyor

1. Air floating conveyor

1.1 Outline

This is the system support belt by air film (200~800Aq air pressure) compared with the conventional roller type conveyor. It can be operated with low noise, power saving and without worry about spillage, since completely sealed.

1.2 Features

This conveyor has such advantages and features as shown in Table-23.

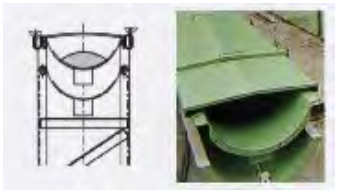
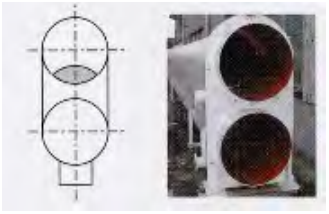
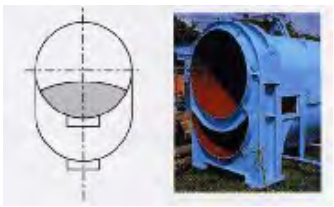
Table- 23: Features and advantage of air floating conveyor

1.	Rollerless	: There is no noise and vibration generated by the carrier and return side because there is no middle portion rollers. In addition, free replacement of roller or maintenance of such cleaning of dropped dusts.
2.	Belt supporting by air film	: Supporting belt by air film instead of rollers. Therefore, it can be reduced motor capacity and saved energy, since the coefficient of friction is low compared with conventional conveyor.
3.	Completely sealed	: No dusts or odors leak to the outside because the conveyor belt is fully sealed. Accordingly, it is ideal for urban environmental protection and plants.
4.	Space saving	: Equipment can be small, since large carriage cross section and high speed transportation. Therefore, at least about 50% spaces saving is allowed compared with conventional belt conveyor.

1.3 Capacity

Example of various capacity of this conveyor is shown in Table-24.

Table- 24: Typical specification of air floating conveyor (UBE)

Name	MT Series（Small size）	WP Series（Medium size）	BU Series（Large size）
Shape of cross section	Trough type	Vertical double tube type	U-pipe type
			
Capacity	～100t/h	100～1,500t/h	1,000～5,000t/h
Width of belt	300～650mm	400～1,200mm	1,000～1,600mm
Pipe dia.	—	300A～900A	750A～1,200A

Article 54-2-4. Dual pipe conveyor

1. Dual pipe conveyor

1.1 Outline

This is the enclosed conveyor as shown in Photo-110 which is floated by ejected air from air holes as shown in Photo-11 and is reciprocated in the double pipes as shown in Fig-25, 26, and made it possible not only one way but round trip transportation.

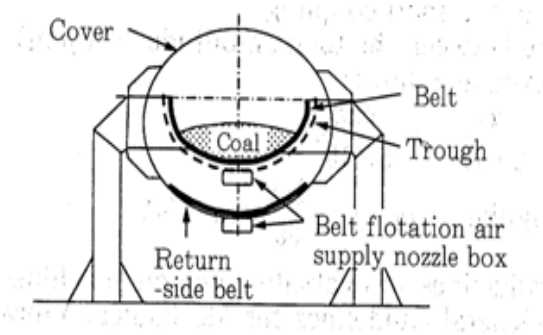


Fig- 25: Air floating conveyor (1)

Reference: P-150 of Handbook for thermal power facility Ver.7 2008: TENPES
http://www.bridgestone.com/products/diversified/conveyorbelt/products/pipe_conveyor_belt.html

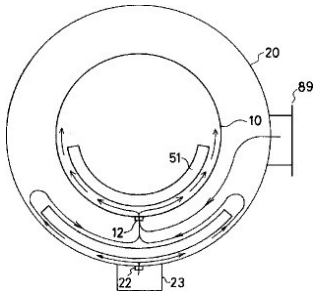


Fig- 26: Air floating conveyor (2)

http://www.ekouhou.net/%E5%8F%AF%E6%92%93%E6%80%A7%E3%82%B3%E3%83%B3%E3%83%99%E3%82%A2%E3%83%99%E3%83%AB%E3%83%88/A,H07-206122_d_000002.jpg

Photo- 110: Air floating conveyor (3)

http://www.ubemachinery.co.jp/seihin/b_hand/air.htm

Photo- 111: Air hole for air floating cushion

http://xinology.com:888/photo/GPESC/glass-printing/glass-screen-printing/features-specs/fully-automatic/Air-Holes-Creat-Air-Floating-Cushion-Generated-by-Air-Blower-Beneath-Printing-Bed.jpg

1.2 Features

This conveyor has such advantages and features as shown in Table-25.

Table- 25: Advantage of air floating conveyor

1.	Energy conservation, non-pollution	: It can be reduced power consumption and noise compared with pneumatic conveyor and chain conveyors, since lifting up belt conveyor and transport in high speed.
2.	Saving of labor and maintenance	: There is serpentine of belt, since there is no carrier rollers and return rollers in the middle portion.
3.	Space saving	: The compact design can be performed with compact cross-section in a space about 1/6 compared to conventional conveyor with dust collector.
4.	Construction free	: Only a single pipe presents in appearance, which is lightweight and easy to install.
5.	Hygiene	: No spills, leaking, contamination from external in completely sealed. There is no contamination due to condensation, since belt is floating and ventilated at all times by air.

1.3 Capacity

Example of various capacity of this conveyor is shown in Table-26.

Table- 26: Capacity of air floating conveyor

Type	Belt width (mm)	Capacity (m^3/h)	Power consumption (kW)		Length (m)	
			Driver	Blower	Min.	Max.
DPC 300	300	76	5.5	1.5	30	100
DPC 400	400	156	7.5	2.2	30	150
DPC 500	500	265	11	3.7	30	200
DPC 600	600	396	15	5.5	30	300
DPC 700	700	567	18.5	5.5	50	300
DPC 800	800	756	30	7.5	50	400

Article 54-2-5. Bucket type vertical conveyor

1. Bucket type vertical conveyor

   The bucket elevator has types such as the centrifugal discharge belt chain and the inductive discharge type, etc. and is suitable for vertical and diagonal transportation of bulk materials. Transport goods are carried by bucket attached to a belt chain travelling in the case.

Fig- 27: Vertical bucket conveyor

http://www.p-wholesale.com/cn-pro/19/746to2/central-chain-high-output-bucket-elevator-zyl-series-673988.html

Photo- 112: Vertical bucket conveyor

http://www.sankyokikai.jp/info/index.html

Article 54-2-6. Bucketless type vertical conveyor

1. Bucketless type vertical conveyor

   The bucketless conveyor as shown in Photo-113, 114 are the type to lift up bulk materials sandwiched between belts, whereas the bucket type elevator as Shown in Fig-27, Photo-112 is raising

up bulk materials by bucket attached on the belt chain. The lower and upper part is released into two belt sheets and the normal flat conveyor belt. Two rollers tuck on the edge of belt preventing spillage.

Photo- 113: Steep slope belt conveyor

http://www.conveyor.co.jp/products/varticalconveyor.html

Photo- 114: Vertical belt conveyor

http://www.drb.co.jp/01_product/product_03_04.htm

Article 54-2-7. Distribution method to bunker

1. Distribution method to bunker

(1) Belt conveyor method

It can be supplied coal for two bunkers by operating conveyor reversibly as shown in Fig-28, and distributed for three bunkers in combination branch chute and conveyor belt as shown in Fig-29.

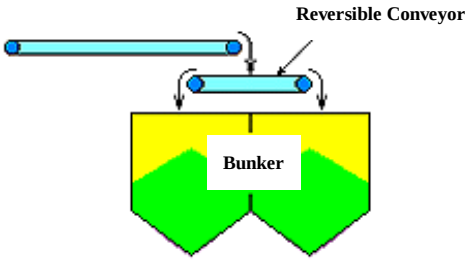


Fig- 28: Reversible conveyor type (1)

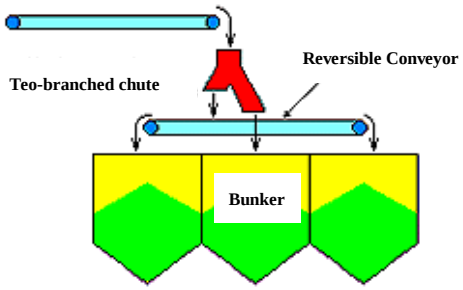


Fig- 29: Reversible conveyor type (2)

(2) Chain conveyor method

It can be supply coal to the plural bunkers by combination of chain conveyor and original gate valves and is excellent in terms of compactness, tightness and cost (no need to clean dropped dust) as shown in Fig-30, it is mainly applied for power plant 200MW or less or less than 200ton /H of transportation capacity.

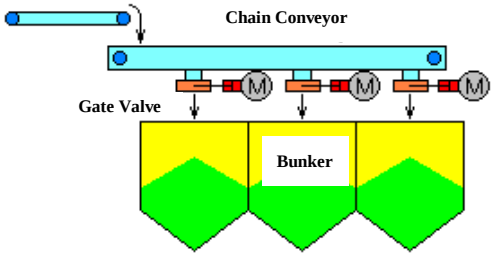


Fig- 30: Chain conveyor type

(3) Scraper method

It can be supplied coal to the plural bunkers by the scrapers which are installed on the conveyor belt as shown in Fig-31.

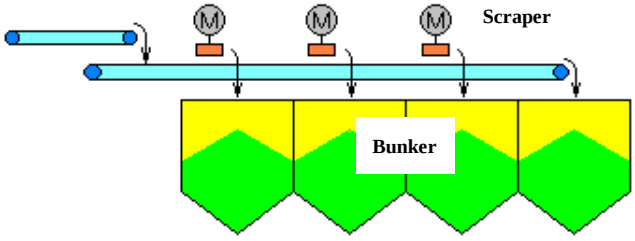


Fig- 31: Scraper type

(4) Tripper method

It can be supply coal to the plural bunkers continuously and uniformly by tripper which moves to the upper surface of coal bunker as shown in Fig-32, it is mainly applied for large power plant 200MW and more.

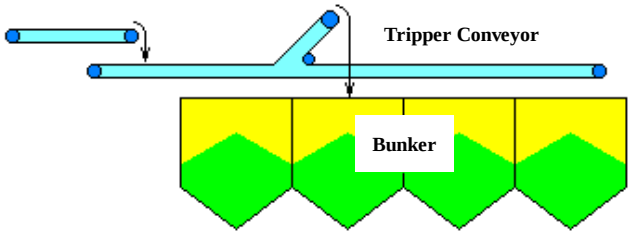


Fig- 32: Tripper type

(5) Shuttle conveyor method

It can be supplied coal to the plural bunkers continuously and uniformly by shuttle conveyor as shown in Fig-33, which the belt conveyor itself moves by wheels top of coal bunker and reversing.

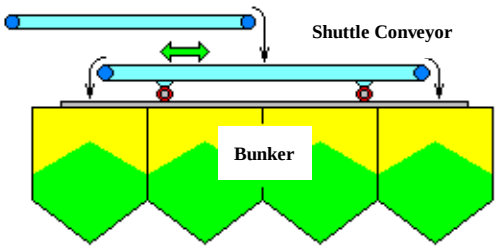


Fig- 33: Shuttle conveyor type

Article 54-2-8. Tripper

1. Tripper may be used to supplement coal to bunker evenly folding as shown in Photo-115 and 116.This method have been extensively used in the past, because there are fewer devices.

Photo- 115: Tripper on bunker (1)

http://www.cobitengg.com/images/pr_tripper1.jpg

Photo- 116: Tripper on bunker (2)

http://www.asi.com/espanol/bulk-material/newIatan4.jpg

Article 54-2-9. Shuttle conveyor

1. A horizontal conveyor which can be moved in both directions such as Photo-117 and 118 are applied to supplement coal evenly to bunker as well as Photo-115. Tall building can be saved height compared with the tripper system.

Photo- 117: Shuttle conveyor on bunker

http://conveytechgroup.com/products.htm

Photo- 118: Shuttle conveyor

http://www.equipmentbazar.com/ProductDetails.aspx?BrandID=14&smid=6&sname=TRF%20Shuttle%20Conveyors

Article 54-2-10. Environmental measures

1. The noise of belt conveyor are divided occurring due to the collision with chute or attribution to coal themselves when transshipment of coal conveyors and such devices itself due to the motor and reduction gear. The rubber lining cushions on the collision surface of the coal is provided for the former, while the latter employs a low noise devices such as tight cover are effective or sound absorbing material can be used if necessary. Recently, the air floating conveyor type is also employed in stead of belt and roller type as the measure s to prevent noise caused by contact with the conveyor belt roller. The galley or cover is applied as measure for soundproof, waterproof and dustproof as shown in Photo-119 and 120.

Photo- 119: Conveyor gallery

http://s0.geograph.org.uk/photos/16/44/164402_f2fdc4e5.jpg

Photo- 120: Conveyor cover

http://www.anmopyc.com/en/product/cover_for_conveyor_belts_capotex

Article 55. General provision of coal dressing facility

Article 55-1-1. Overview of PC combustion facility

1. Coal firing system

There are the stoker combustion system and the pulverized coal combustion system as the wet type system and the cyclone furnace system and the slug tap furnace system as the wet type system. The pulverized coal combustion system is applied recent almost coal-fired boiler.

1.1 Grate firing system

There are the hand spread stoker and the stoker with mechanical grate. The hand spread stoker is not suitable for the generation boiler and is used for small boilers. The grate firing system has the features that less power consumption compared with pulverized coal firing system, less scattering of ash. Recently, it became obsolete for large scale power boiler for generation and is used special cases such as municipal waste incineration.

The types of stoker combustion are summarized in Table-27;

Table- 27: Type of stoker

1.	Spreader stoker	To spreading coal mechanically over the burning layer and burning
2.	Travelling grate stoker	The great to burn coal is moved by other support device and burning coal on it.
3.	Chain great stoker	The chains are combined into a chain grate to move and combustion.
4.	Step grate stoker	Coal is supplied from hopper provided at the top onto the inclined grate like staircase and cinder is slipped on the grate and taken from the bottom after coal burning.

1.2 Dry pulverized coal firing system

Pulverized coal firing system has advantage that small excess air compared with the grate combustion system, wide range of coal, response to quick load variation, high combustion efficiency, easy to adjust the ignition and extinguish in a short time, easily controlled by automatic, easy to co-combustion of liquid fuel or gas fuel. It has also the disadvantage that high equipment cost, high power requirements, high maintenance cost, resulting in noise and vibration and the like. The pulverized coal combustion has the direct combustion system and PC coal bin system, combustion system and component equipment is slightly different.

(1) Direct firing method

Direct combustion system is the method to send pulverized coal directly to PC burner as shown in Fig-34. Coal sent by conveyor from the coal storage yard is stored in coal bunker provided near the boiler. Coal from the coal bunker goes into the coal chute, coal-gate, coal feeder which has weighing function and fed to the coal mill, and it will be sent to the pulverized coal burner for burning. Meanwhile, preheated combustion air is divided into primary air and secondary air. Primary air is sent into the coal mill through the primary air fan and conveys pulverized coal to burner; secondary air is supplied around burner to obtain better mixing of air and pulverized coal. The advantage of direct combustion is that it is easy to handle, equipment cost is cheep, dryer can be omitted by preheated air, and this have been adopted for most modern boilers.

(2) PC coal bin combustion system

The bin system as shown in Fig-37 is adopted for the anthracite which has volatile matter less than 15% boiler. This bin system has the advantage of stable combustion of fuels which is difficult to ignite due to less volatile matter such as petroleum coke and anthracite by means of separating the transport system to coal mill with burner, and taking pulverized coal concentration (fuel flow/amount of primary air) on large.

1.3 Wet firing System

The cyclone furnace and the slag tap combustion furnace to melt a large coarse coal in stead of abovementioned pulverized coal are suitable for the combustion of coal with low ash melting

temperature.

(1) Cyclone furnace

The cyclone furnace, which was developed by B&W America, primary chamber covered by a special refractory (cyclone furnace) has the structure as shown in Fig-35, which coarse coal is blown at high speed in a cyclone furnace and burn winding with intense vortex. Features of cyclone combustion, it can be burned in large grains size compared with pulverized coal (95% passing of 6mm mesh in case of front coal expression, 30% passing of 200 mesh in case of side coal expression), therefore, it is required less facility cost, maintenance cost and power consumption cost, since it is not required a coal mill but a crusher, less dirt and wear of heat transfer surfaces by fly ash.

(2) Slug tap furnace

The combustion chamber is divided into primary and secondary combustion chamber furnaces. Coal is combusted in the primary chamber under high temperature and high load, the ash is taken out as molten slag. Fig-36 shows the structure of the slag tap furnace.

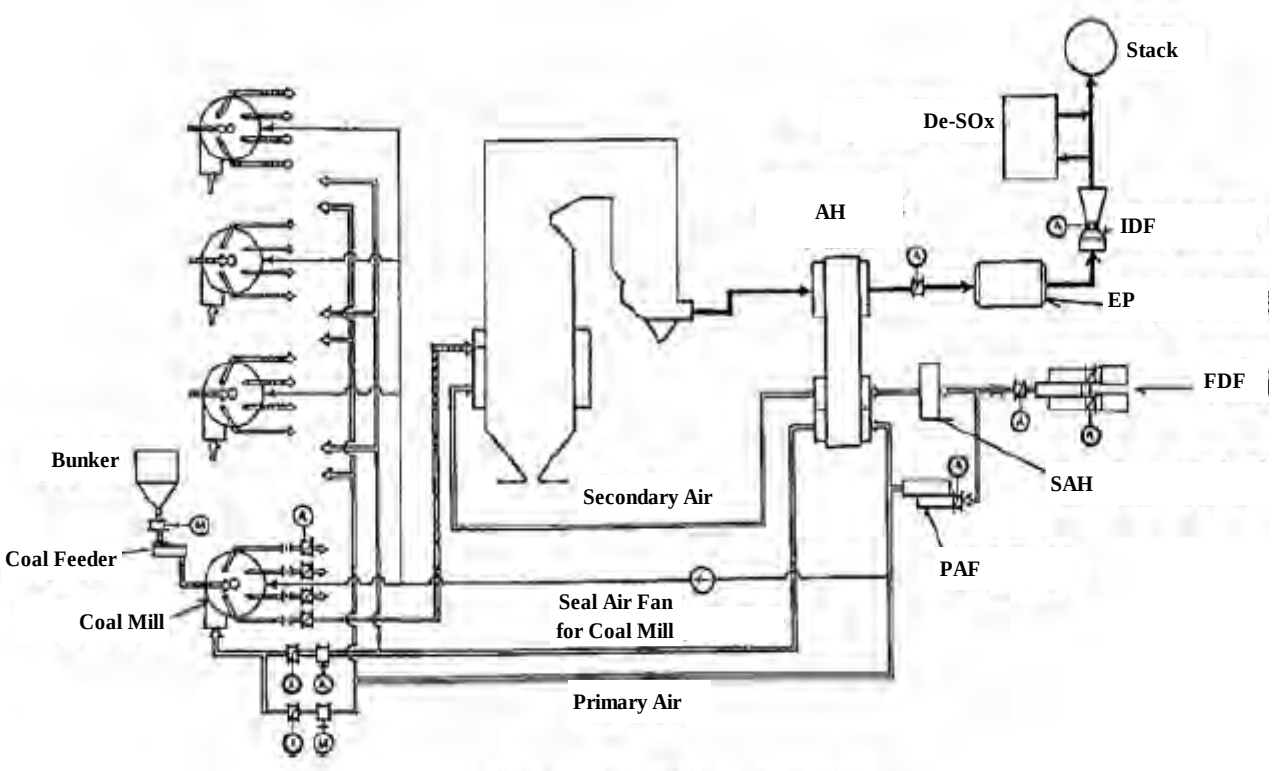


Fig- 34: Direct firing method

Reference: P-45 of Journal (No.590: Nov. /2005): TENPES

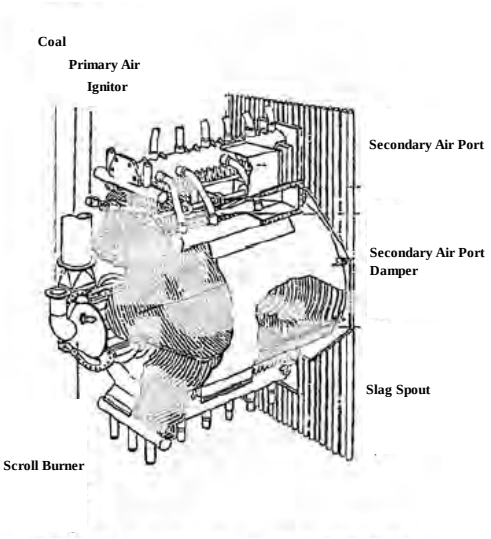


Fig- 35: Cyclone furnace

Reference: P-46 of Journal (No.590: Nov. 2005): TENPES

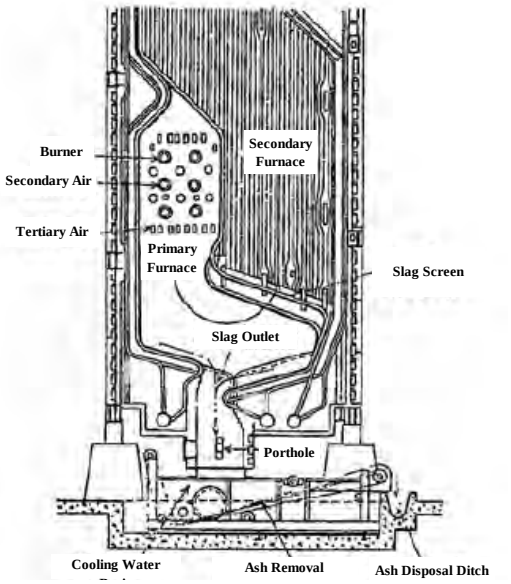


Fig- 36: Slag tap furnace

Reference: P-46 of Journal (No.590: Nov. 2005): TENPES

Article 55-1-2. System for direct combustion

1. Pulverized coal combustion facilities are classified into direct type facilities in which pulvelized coal crushed by a coal pulverizer is fed directly into the furnace and storage type facilities that store pulverized coal temporarily and discharge it as needs arise Fig-37 shows a schematic illustration of a direct type facility.

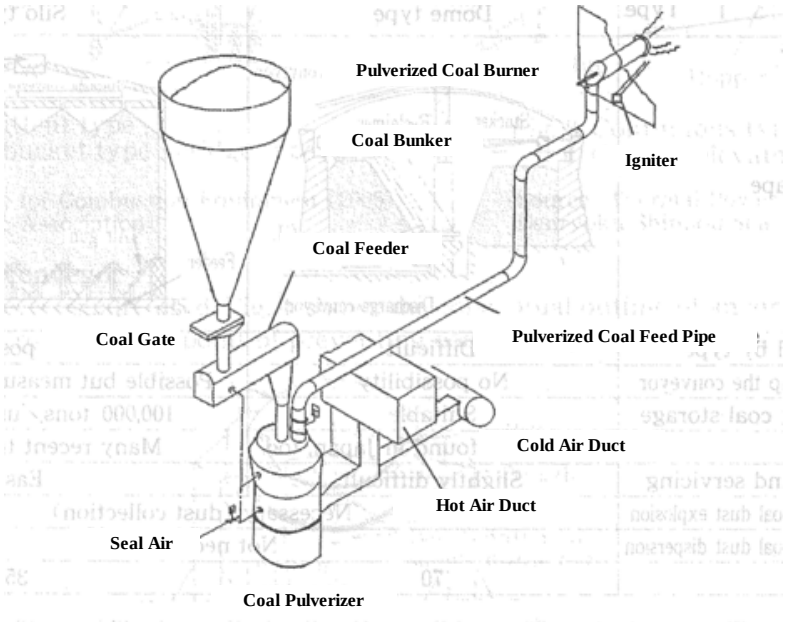


Fig- 37: Overview of pulverized coal combustion facility

Reference: P-152 of Handbook for thermal power facility Ver.7 2008: TENPES

Article 56. Coal bunker

Article 56-1. Coal bunker

1. The coal which is discharged from stock yard is normally sent by conveyor belt to coal bunker and the required amount of coal is sent to pulvelizer from bottom of bunker by coal feeder. The coal bunkers as shown in Photo-121, 122, 123, and 124 are installed in every coal pulvelizer and bottom portion of hopper is connected to the coal feeder. Filling of coal bunker is mainly performed by tripper, shuttle-conveyor and scraper. It is necessary to seal top of bunker as much as possible and to prevent dispersal of coal dust, if needed, because significant dust is generated. The storage capacity of coal bunker is determined in considering a balance of coal consumption of boiler, amount of coal feeding and uptime of coal conveyor. In case of large power plant, coal storage capacity in coal bunker is planned for 12~16 hours. In addition, it may be reduced up to about 10 hours in the power plant which can be fed 24 hours.

Photo- 121: Coal bunker (1)

http://deas.net/g11.jpg

Photo- 122: Coal bunker (2)

http://www.draxteachingzone.org/explore/img/img_04.png

Photo- 123: Coal bunker (3)

http://image.shutterstock.com/display_pic_with_logo/73593/73593,1161725776,9/stock-photo-power-plant-coal-silos-above-pulverizers-2051261.jpg

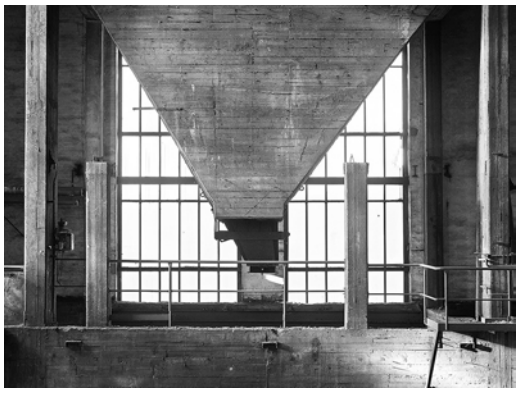


Photo- 124: Coal bunker (4) RC

http://hebig.org/blog/004173.php

Article 56-2. Angle and liner of coal bunker

1. The cone angle of bunker must be greater than the repose angle of coal.
2. Flow failure phenomenon such as coal obstruction or reducing discharge occur due to a “Bridge”, “Rat hole”, “Funnel flow” in the reservoir such of the coal bunker, hopper and silo. As the countermeasure, following are applied;
   (1) It must be considered the insert, eccentricity of cone, corn angle, size of discharge hole, when designing the shape of bunker.
   (2) It is better to provide the engineering plastic or stainless steel lining which has a small coefficient of friction in general as shown in Photo-125 and 126.

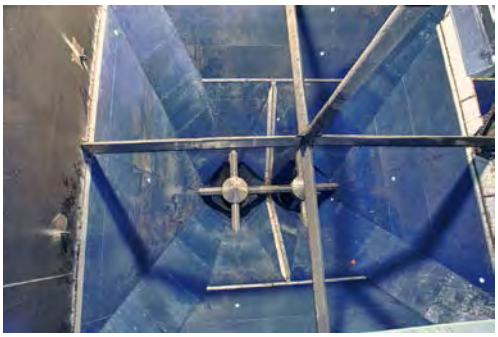


Photo- 125: Bunker liner (1)

http://www.lawrenceindustriesnow.com/images/TIVAR%2088%20Coal%20Bunker%20Liner.jpg

Photo- 126: Bunker liner (2)

http://www.kalenborn.de/images/xKALEN-Bunker_leer.gif

   (3) The method to prevent the phenomenon such as “Bridge” by means of fluidizing the powder in the silo, etc, by blowing air through the fluidize plate to the silo and hopper as shown in Photo-127 and 128.

Photo- 127: Air cannons (1)

http://www.aircannonbiz.com/doc/service-case.html

Photo- 128: Air cannons (2)

http://www.manufacturer.com/product/m6989741-Air+Cannon+.html

   (4) The method forced to destroy the “Bridge” by installing the knocker, vibrators, air cannon and vibro-hopper which subjects to shock or vibration as shown in Photo-129 and 130.

Photo- 129: Air vibrator (1)

http://nvn-japan.com/netter_apri_01.shtml

Photo- 130: Air vibrator (2)

http://www.process-worldwide.com/mechanical_process_technology/powder_conveying_equipment/articles/376469/

However, there is no definitive solution which can be applied to all coal and conditions. The effect appears in one of above measures in some cases; however, it is general to apply measures a combination of several methods depending on the type and properties of the coal.

3. Although wear reduction is associated with anti-slip, it is achieved by means of putting a stainless steel liner and the engineering plastic which has a small coefficient of friction in general as shown in Photo-125, 126. Ceramic lining is also applicable as shown in Photo-131 and 132.

Photo- 131: Ceramic lining (1)

http://www.astecinc.com/index.php?option=com_content&view=article&id=310&Itemid=231

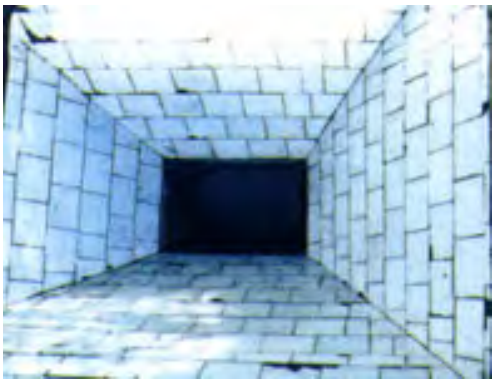


Photo- 132: Ceramic lining (2)

http://www.groupline.co.za/products/flowtile.asp

Article 56-3-1. Thermometer for bunker

1. It is preferable to provide the monitoring device as shown in Fig-38 and Fig-39 to monitor the temperature rise in the bunker as well as indoor coal yard when the plant is stopped in the long time while the remaining coal, although storage period in the bunker is shorter than in stock yard in general.

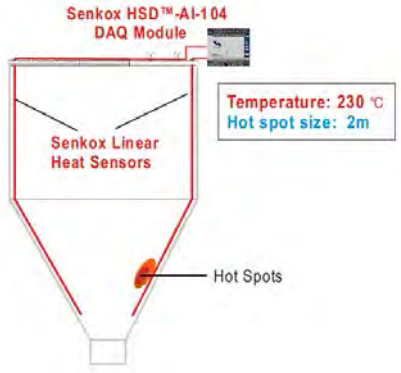


Fig- 38: Hot spot detection system

http://www.senkox.com/images1/applications/coal_bunker2_e.png

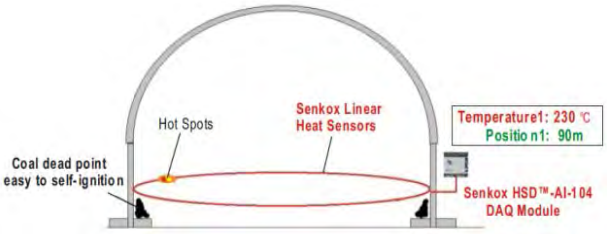


Fig- 39: Hot spot detection system

http://www.senkox.com/applications_1.html

Article 57. Coal feeder

Article 57-1-1. Coal feeder

1. The coal feeder controls coal supply depending on the load of boiler changing the rotational speed as shown in Photo-133 and 134. A table feeder with a rotating disk, screw feeder with a screw and drag feeder with a drug chain are used in case of direct combustion system. The rotating disc Bailey feeder is used for feeding of pulverized coal in case of fuel storage system.

Photo- 133: Coal feeder (1)

http://www.keikoren.or.jp/seihin/photo/02-08-010-190-03.jpg

Photo- 134: Coal feeder (2)

http://www.geocities.jp/scaleman_bb/img034.gif

Article 58. Coal pulverizer

Article 58-1-1. General

1. The pulvelizer is the life of pulvelized coal firing system and there are varieties of type in its structures. They are divided into centrifugal force, gravity or spring force or impact, etc. in the effect, and can be divided into horizontal and vertical in structure and shape. They may be divided into the positive pressure type which applying primary air fan and negative pressure type which applying coal discharger, or may be divided into coal mill and coarse crusher.

Article 58-1-2. Vertical coal mill

1. The typical construction of vertical coal mill is shown in Fig-40 and Fig-44. IHI-VS mill (Fig-41), Mitsubishi-MRS mill (Fig-42), Hitachi-MPS mill (Fig-43), Roshe crusher, Earthtechnica-KVM mill are the vertical type with roller, ball and table, which crush coal by ball or roller rotating in the stationary ring by crushing effect.

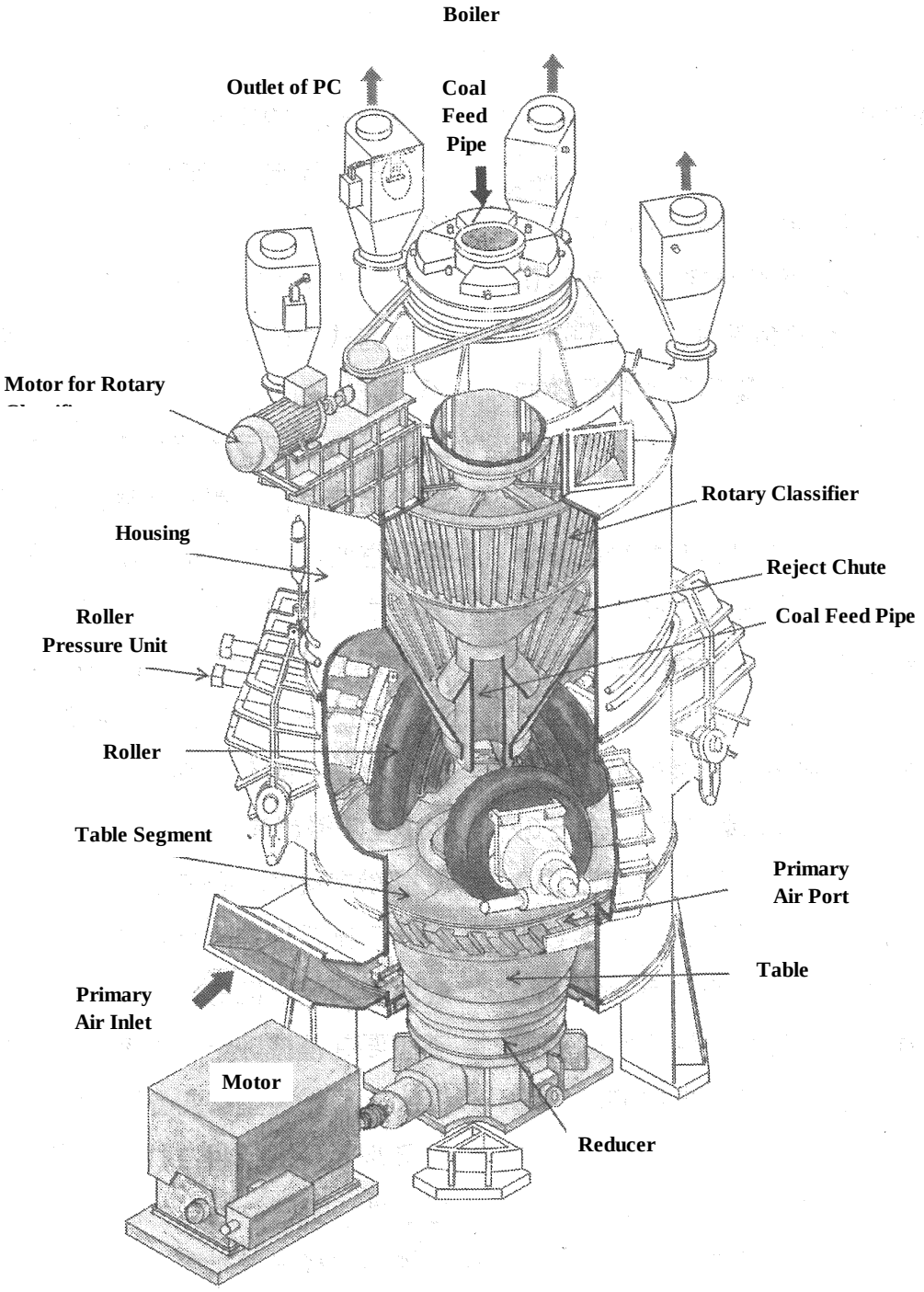


Fig- 40: Typical construction of vertical coal mill

Reference: P-44 of Journal (No.592/ Jan. /2006): TENPES

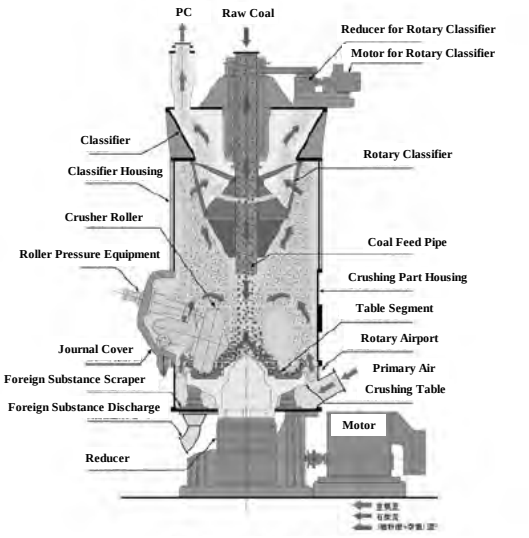


Fig- 41: VS vertical mill (IHI)

Reference: P-46 of Journal (No.590: Nov. 2005): TENPES

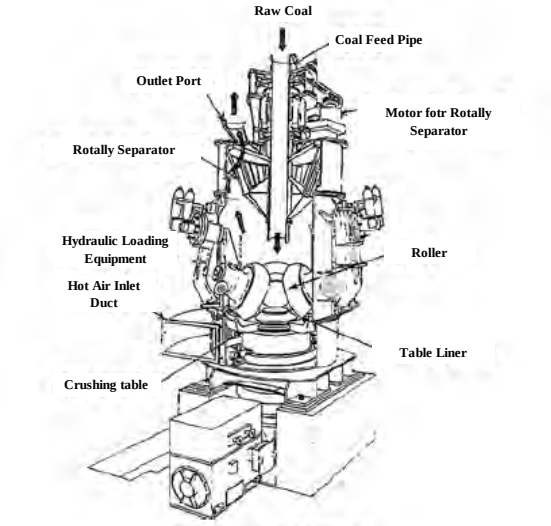


Fig- 42: MRS vertical mill (MHI)

Reference: P-47 of Journal (No.590: Nov. 2005): TENPES

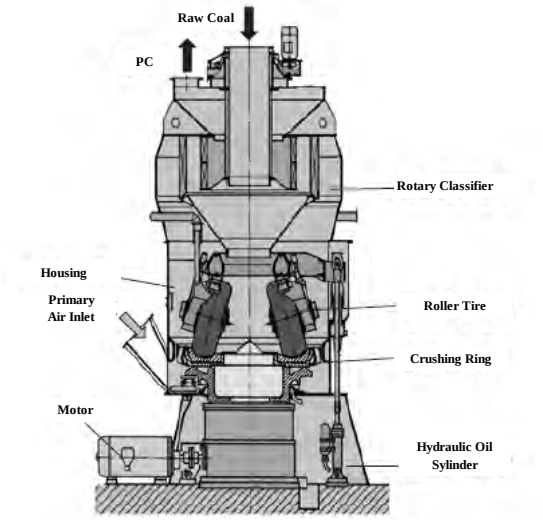


Fig- 43: MPS vertical mill (Hitachi)

Reference: P-47 of Journal (No.590: Nov. 2005): TENPES

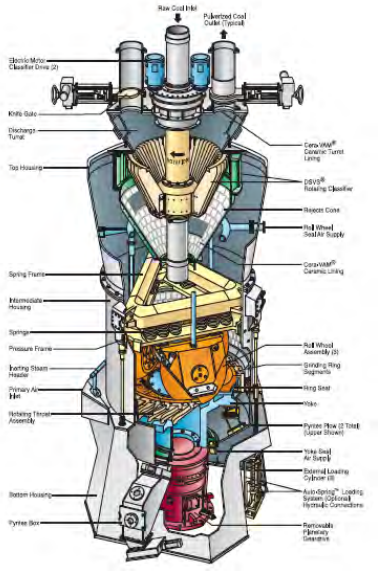


Fig- 44: Roll wheel pulverizer (B&W)

Reference: E101-31438 brochure of B&W 2002

Article 58-1-3. Horizontal coal mill

1. The ball mill drum of the horizontal tube mill such as IHI ball mill (as shown in Fig-45), Ube tube mill and MHI tube mill is rotated at low speed and number of steel balls in the drum crush coal by crushing effect. Pulvelized coal is transported with preheated hot air to coal burner.

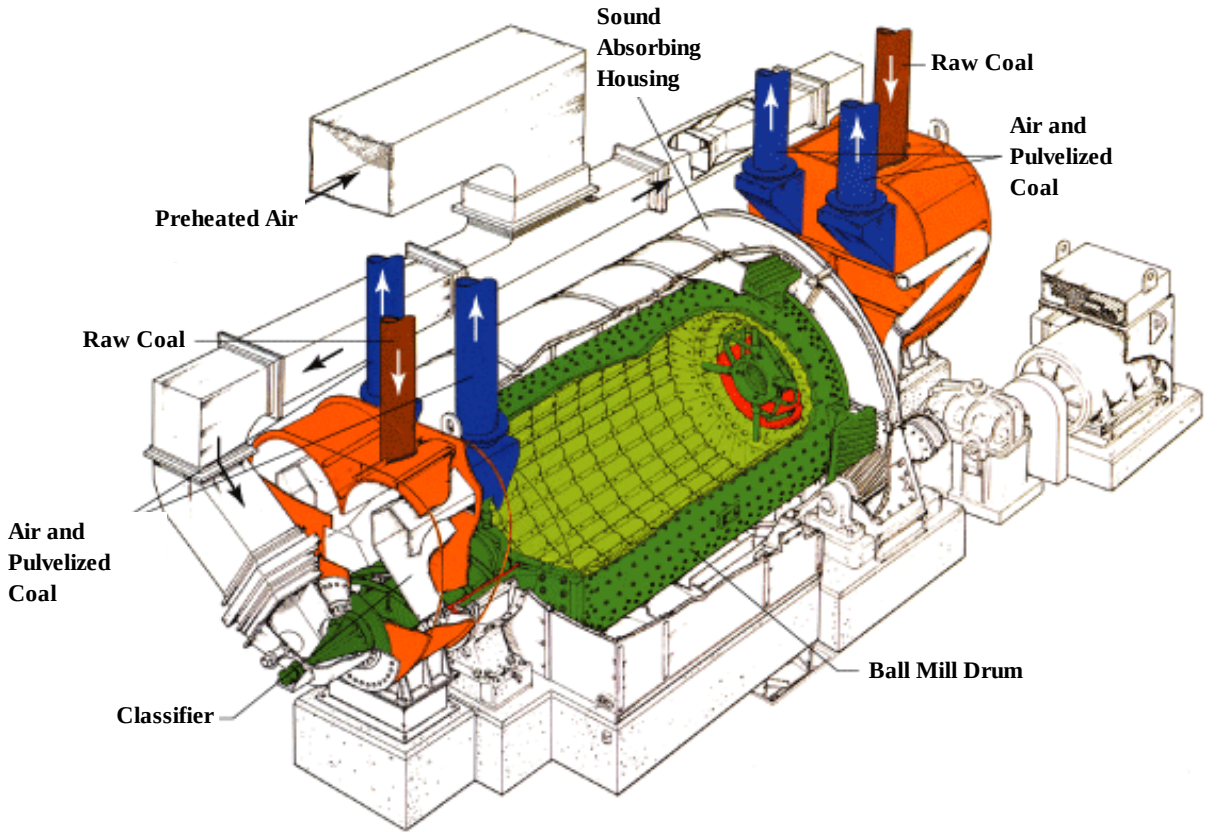


Fig- 45: Horizontal coal mill (IHI)

Article 58-1-4. Crusher

1. Hammer mill (e.g. GS mill) as shown in Fig-46 and beater fan mill (e.g. DGS mill) which integrated crusher and fan crush coal by fast rotating hammers and heads applying the impact function, it is used for crumbly coal or coarse crushing. The crushing of hard coal is performed through the gap of double rolls as shown in Photo-136, 137. Photo-135 is the mobile type crusher.

Photo- 135: Coal crusher

http://www.crushersolution.com/images/solution/coal-crusher.jpg

Photo- 136: Double rolls crusher

http://w13.itrademarket.com/pdimage/05/1934405_doublerollcoalcrusher.jpg

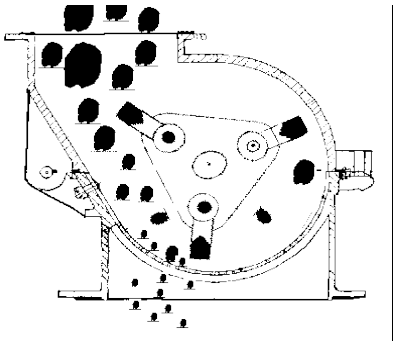


Fig- 46: Hammer crusher

http://www.shibang-china.com/info/image/hammer-crusher.gif

Photo- 137: Double rolls crusher

http://image.made-in-china.com/2f0j00sMcTSkogrCuZ/Coal-Double-Tooth-Roll-Crusher-Machine.jpg

Article 58-1-5. PC bin system

1. PC coal bin system as shown in Fig-47 is the system adopted for the boiler applying anthracite with volatile matter less than 15%. This system has the advantage of stable combustion such as the petroleum coke or anthracite which is difficult to ignite fuel due to volatile matter, since it is possible to take large concentration of pulverized coal (carrying amount of primary air/ fuel flow) by means of separating the transport system to the hot air to the coal pulverizer and the burner compared with the direct combustion system.

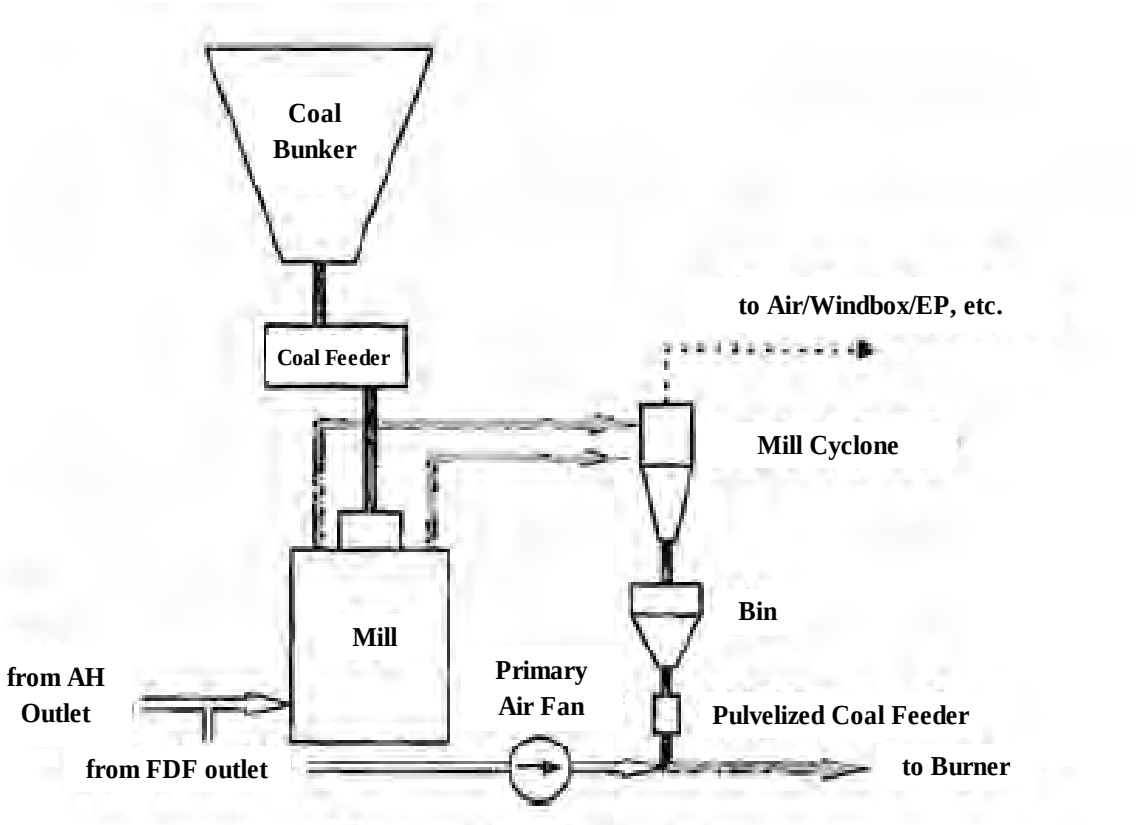


Fig- 47: PC coal bin system

Reference: P-45 of Journal (No.590: Nov. /2005): TENPES

Chapter-3. Reference International Technical Standards

The reference international standards for designing coal fuel handling facility are organized in Table-28.

Table- 28: Reference international technical standards

Number	Rev.	Title	Content
ASME B20.1	2009	Safety Standard for Conveyors and Related Equipment	This standard presents certain guides for the design, construction, installation, operation, and maintenance of conveyors and related equipment. The conveyors may be of the bulk material, package, or unit-handling types, where the installation is designed for permanent, temporary, or portable operation.
ASME B30.18	2011	Stacker Cranes (Top or Under Running Bridge, Multiple Girder with Top or Under Running Trolley Hoist)	This standard is applied to the construction, installation, operation, inspection, and maintenance of hand-powered and power-driven overhead and gantry cranes that have a top or under running multiple girder bridge with a vertically guided carriage, with or without a top or under running trolley. The requirements included in this volume also apply to stacker cranes having the same fundamental characteristics, such as cantilever gantry and semi-gantry stacker cranes.
ASME PTC4.2	1969	Coal Pulverizers	The purpose of this code is to establish procedures for conducting performance tests to determine: Capacity, Fineness of product, Raw coal feed, Grindability, Moisture, Sizing, Power consumption and Effect of changes in raw coal Characteristics on product fineness, pulverizer capacity, and power consumption. Effect of changes in pulverizer component settings on product fineness, pulverizer capacity, and power consumption. This Code applies to the pulverizing system as a whole, including all the component parts necessary to take the raw coal, hot air and tempering air at the system inlet, and deliver pulverized coal in proper mixture with air and/or flue gas at the desired temperature at the outlet of the system.
ASME BPVC Section 7	2010	Recommended Guidelines for the Care of Power Boilers	The purpose of these recommended guidelines is to promote safety in the use of power boilers. These guidelines are intended for use by those directly responsible for operating, maintaining, and inspecting power boilers.
ASTM D121-09a	2009	Standard Terminology of Coal and Coke	This terminology defines the technical terms used in standards that are the responsibility of Committee D05 on Coal and Coke.

Number	Rev.	Title	Content
ASTM D388-05	2005	Standard Classification of Coals by Rank	This specification covers the classification of coals by rank, that is, according to their degree of metamorphism, or progressive alteration, in the natural series from lignite to anthracite. These coals are mainly composed of vitrinite. The classification shall be based on gradational properties that depend on the degree of metamorphism. The classification shall also be according to fixed carbon and gross calorific value calculated to the mineral-matter-free basis.
ASTM D1757-03	2009	Standard Test Method for Sulfate Sulfur in Ash from Coal and Coke	This test method pertains to the determination of sulfate sulfur in coal or coke ash. Formerly under the jurisdiction of Committee D05 on Coal and Coke, this test method was withdrawn in October 2009.This standard is a classical gravimetric sulfate method that is sometimes improperly cited for use in contracts. In addition the Eschka's Mixture that is vital for the test method is no longer available commercially.
ASTN D2013	2007	Standard Practice for Preparing Coal Samples for Analysis	Other standards are used to collect the gross sample: Practice D2234/D2234M allows for one division of the gross sample before crushing. The mass and top size of the gross or divided sample collected by using these guides and practices are usually too large for chemical or physical testing. Practice D2013 provide instructions for reducing and dividing the gross or divided sample, by on-line or off-line processes, or both, to a top size and mass suitable to the performance of testing. Any bias in the gross or divided sample before adherence to this practice will remain in the final sample resulting from use of this practice. Therefore, carefully select the standard to be used to collect the gross sample.
ASTM D3174-11	2011	Standard Test Method for Ash in the Analysis Sample of Coal and Coke from Coal	Ash, as determined by this test method, is the residue remaining after burning the coal and coke. Ash obtained differs in composition from the inorganic constituents present in the original coal. Incineration causes an expulsion of all water, the loss of carbon dioxide from carbonates, the conversion of iron pyrites into ferric oxide, and other chemical reactions. Ash, as determined by this test method, will differ in amount from ash produced in furnace operations and other firing systems because incineration conditions influence the chemistry and amount of the ash. References for correcting ash results determined by this test method to a mineral-matter-free basis are listed in Classification D388, Section 8.

Number	Rev.	Title	Content
ASTM D3302	2010	Standard Test Method for Total Moisture in Coal	The collection and treatment of the sample as specified for the referee method is intended for the express purpose of determining the total moisture in coal. The standard is available to producers, sellers, and consumers as a method of determination when other techniques or modifications are not mutually agreed upon. The commercial method, which determines total moisture content of the crushed and divided sample, is designated as the method for total moisture for routine commercial practice.
ISO 1170	2008	Coal and coke—Calculation of analyses to different bases	This standard gives equations that allow analytical data relating to coal and coke to be expressed on the various different bases in common use. Consideration is given to corrections that can be applied to certain determined values for coal prior to their calculation to other bases.
ISO 540	2008	Hard coal and coke—Determination of ash fusibility	This standard specifies a method of determining the characteristic fusion temperatures of ash from coal and coke.
ISO 23380	2008	Selection of methods for the determination of trace elements in coal	This standard provides guidance on the selection of methods used for the determination of trace elements in coal and coal ash. The trace elements of environmental interest include arsenic, beryllium, boron, cadmium, chlorine, chromium, cobalt, copper, fluorine, lead, manganese, mercury, molybdenum, nickel, selenium, vanadium and zinc. To this list can be added the radioactive trace elements, thorium and uranium.
ISO 589	2008	Hard coal—Determination of total moisture	This standard describes two methods for determination of the total moisture content of hard coals, a two-stage method and a single-stage method. For either method there is a choice between drying in air and drying in a nitrogen atmosphere. Depending on the coal rank, there may be systematic differences between the results obtained by drying in the different atmospheres on subsamples of a sample. Drying in a nitrogen atmosphere is suitable for all hard coals, while drying in air is only suitable for hard coals not susceptible to oxidation.
ISO 23873	2010	Hard coal—Method for the measurement of the swelling of hard using a dilatometer	This standard describes a method for the measurement of the swelling of hard coal using a dilatometer.
ISO 15237	2003	Solid mineral fuels—Determination of total mercury content of coal	This standard specifies a procedure for the determination of the total mercury content of coal.
ISO 15238	2003	Solid mineral fuels—Determination of total cadmium content of coal	This standard specifies a procedure for the determination of the total cadmium content of coal.

Number	Rev.	Title	Content
ISO 18283	2006	Hard coal and coke—Manual sampling	This standard defines the basic terms used in manual sampling of hard coal and coke and describes the general principles of sampling. ISO 18283:2006 specifies procedures and requirements for establishing a manual sampling scheme, methods of manual sampling, sampling equipment, handling and storage of samples, sample preparation and a sampling report.
ISO 20905	2004	Coal preparation—Determination of dust/moisture relationship for coal	This standard sets out a laboratory procedure for the dust testing of higher rank coals. The procedure defines a means of evaluating the dust/moisture relationship characteristic of a coal and dust extinction moisture (DEM).
NFPA 85	2007	Boiler and Combustion Systems Hazards Code	This code shall apply to single burner boilers, multiple burner boilers, stokers, and atmospheric fluidized-bed boilers with a fuel input rating of 3.7 MWt (12.5 million Btu/hr) or greater, to pulverized fuel systems, to fired or unfired steam generators used to recover heat from combustion turbines [heat recovery steam generators (HRSGs)], and to other combustion turbine exhaust systems. 1.1.1 This code shall cover design, installation, operation, maintenance, and training. 1.1.2 This code shall cover strength of the structure, operation and maintenance procedures, combustion and draft control equipment, safety interlocks, alarms, trips, and other related controls that are essential to safe equipment operation. 1.1.3 Coordination of the design and operating procedures of the boiler furnace or HRSG system and any flue gas cleanup systems downstream of the postcombustion gas passes shall be required. Such coordination shall include requirements for ensuring a continuous flow path from the combustion air inlet through the stack.
NPFA 654	2006	Standard for the Prevention of Fire and Dust Explosions from the Manufacturing, Processing, and Handling of Combustible Particulate Solids	This standard shall apply to all phases of the manufacture, processing, blending, pneumatic conveying, repackaging, and handling of combustible particulate solids or hybrid mixtures, regardless of concentration or particle size, where the materials present a fire or explosion hazard. 1.1.2 This standard shall apply to systems that convey combustible particulate solids that are produced as a result of a principal or incidental activity, regardless of concentration or particle size, where the materials present a fire or explosion hazard.
NFPA 8502	1999	Standard for the Prevention of Furnace Explosion/Implosions Multiple Burner Boilers	This document was withdrawn in Fall 2000 and incorporated into NFPA 85.
NFPA 8503	1997	Standard for Pulvelized Fuel Systems	This document was withdrawn in Fall 2000 and incorporated into NFPA 85.

Number	Rev.	Title	Content
OSHA §1910.269		Electric Power Generation, Transmission and Distribution (coal handling)	The operation and maintenance of electric power generation, control, transformation, transmission and distribution lines and equipment. OSHA 1910.269 is the only federally enforceable law that requires FR clothing. It pertains to electric utility workers involved in generation, transmission and distribution. The portion referring to FR clothing states: "The employer shall ensure that each employee who is exposed to the hazards of flames or electric arcs does not wear clothing that, when exposed to flames or electric arcs, could increase the extent of injury that would be sustained by the employee. "Note: Clothing made from the following types of fabrics, either alone or in blends, is prohibited by this paragraph, unless the employer can demonstrate that the fabric has been treated to withstand the conditions that may be encountered or that the clothing is worn in such a manner as to eliminate the hazard involved: acetate, nylon, polyester, and rayon." From a practical standpoint, this means that if an employee's clothing does not melt, ignite or continue to burn during after an arc or flame exposure, the wearer is in compliance. In addition, OSHA 1910.269 was revised to include the following: "Employees in restricted areas shall wear protective equipment meeting the requirements of Subpart I of this Part and including, but not limited to, protective clothing, boots, goggles, and gloves." The protective apparel portions of 1910.269 are currently under review by OSHA. OSHA intends to clarify existing requirements by including the following items: • Utilities must perform a hazard analysis to determine incident energy levels. Workers must wear sufficient clothing to reduce the incident energy level to 1.6 cal/cm^2. • It is the utility's responsibility to ensure workers are protected from 2^{nd} degree burns resulting from electric arcs. • ASTM Standards and test methods are referenced. OSHA 1910.269 applies to workers involved in transmission and distribution, generation, control and metering of electric energy.

Chapter-4. Reference Japanese Technical Standards

The reference Japanese industrial standards for designing coal fuel handling facility are organized in Table-29.

Table- 29: Reference Japanese technical standards

Number	Rev.	Title	Content
JIS B0126	2005	Glossary of terms for thermal power plants—Boilers and auxiliary equipment	This stipulates key terms and rules regarding boilers and associated equipment used in thermal power generation.
JIS B0140	2008	Glossary of terms relating to conveyors—Kinds of conveyors	This stipulates key terms and definitions for commonly used types of conveyors.
JIS B9903	2005	Rollers for belt conveyor	This stipulates the roller and roller bed which is used carrier side and return side of stationary rubber belt conveyor which is used to transportation bulk material (iron ore, sand, coal, cement and grain, etc.).
JIS B8805	2008	Rubber belt conveyors with carrying idlers—Calculation of operating power and tensile forces	This stipulates the calculation formula of the total resistance, composite coefficient of friction, required power, belt tension, haul and cross section of the roller of belt conveyor for bulk materials and stationary rubber belt conveyor applying pulley.
JIS B8809	2004	Calculation for unloading capacity of unloader	This stipulates the calculation method of the unloading capacity for unloader which unloading bulk materials such as coal and iron ore from carrier to hopper by grab bucket.
JIS B8814	1992	Pulleys for belt conveyors	This stipulates regarding pulley for stationary pulley for the belt conveyor which is used mainly for transportation bulk materials.
JIS B8833-1	2008	Cranes-Design principles and for loads and load combinations—Part1: General	This stipulates the general load calculation method and the principle of selection rules for load combinations based on the general limit state design method in order to verify for performance relating to structural and mechanical parts of the crane.
JIS E1203	2007	Synthetic sleepers—Made from fiber reinforced formed urethane	This stipulates about synthetic sleepers for railway which glass fiber and rigid urethane foam are formed into a sleeper shape.
JIS E4001	1972	Railway rolling stock--Vocabulary	This stipulates terms and definitions related to rail vehicles.
JIS E4010	2011	Symbols for railway rolling stock and railway rolling stock ports	This stipulates the symbols represent the rail vehicle and components.
JIS M1002	1978	Calculation of Coal Reserves	This stipulates about calculation for coal in coal deposits.
JIS M8801	2004	Coal—Testing methods	This stipulates about granularity test method, floating teat method, grindability test method, crucible expansion test method, expansion test method, liquidity test method, coking test method, ash molten test method logger test method.

Number	Rev.	Title	Content
JIS M8810	2006	Coal and coke—General rules for sampling analysis and testing	This stipulates general matters common to sampling, analysis and test methods of coals and cokes.
JIS M8811	2006	Coal and coke—Sampling and sample preparation	This stipulates the sampling method of coal and coke, the method to sample preparation, the method to survey quality variation, the method to check accuracy and test method bias.
JIS M8812	2010	Coal and coke—Methods for proximate analysis	This stipulates test method for coal and coke. Test method means to seek water content, ash content, volatile matter and fixed carbon.
JIS M8813	2010	Coal and coke—Determination of constituents	This stipulates component analysis of coal and coke. The component analysis means the determination of carbon, hydrogen, total sulfur, and sulfur in ash, nitrogen, phosphorous, oxygen, and carbon dioxide in coal.
JIS M8814	2008	Col and coke—Determination of gross caloric value by the bomb calorimetric method and calculation of net calorific value	This stipulates method to determine the calorific value of solid mineral fuels at constant volume and at 25^{o}C by Bomb calorimeter calibrated by burning benzoic standard sample or international standard benzoic acid.
JIS M8815	2007	Methods for analysis of coal ash and coke ash	This stipulates the method for how to analyze ash of coals and coke.
JIS M8816	2006	Solid mineral fuels—Methods of microscopically measurement for the materials and reflectance	This stipulates the method for measuring the reflection of coal and its microstructural constituents.
JIS M8817	2007	Methods for determination of forms of sulfur in coal	This stipulates the rules about how coal sulfur analysis by type of class.
JIS M8818	2006	Method for determination of mineral matter in coal	This stipulates the rules about how quantatitative coal mineral matters.
JIS M8819	2006	Coal and coke—Mechanical methods for ultimate analysis	This stipulates method of measuring carbon, hydrogen and nitrogen independently of coals and coke by analyzer equipment or measuring two or three components simultaneously, and quantifies total sulfur and sulfur in ash independently.
JIS M8820	2000	Coal and coke—Determination of total moisture content of a lot	This stipulates the method to measure total water content of lots of coals and cokes.
JIS M8821	2006	Coal—Determination of total mercury content	This stipulates how to determine total mercury in the coal.
JIS Z8815	2009	Test sieving—General requirements	This stipulates general principle of how to perform screening test to measure the particle size distribution of powder and particulate matter.
JIS Z8817	2007	Test method for explosion pressure and rate of pressure rise of combustion dusts	This stipulates method for measuring explosion pressure and pressure rise rate of combustible dust explosions which is flying or suspending in the sealed pressure test vessel.
JIS Z8818	2007	Test method for minimum explosive concentration of combustible dusts	This stipulates method for measuring the lower concentration of explosive dust dispersed and suspended in air.

Chapter-5. Reference TCVN

The reference Vietnamese national standards for designing coal fuel handling facility are organized in Table-30.

Table- 30: Reference TCVN

Number	Rev.	Title	Content
TCVN 0172	2007	Hard coal. Determination of total moisture	Tiêu chuẩn này quy định hai phương pháp xác định độ ẩm toàn phần của than đá. Phụ thuộc vào cấp than, có thể có sự chênh lệch mang tính hệ thống giữa các kết quả thu được bằng cách sử dụng các phương pháp khác nhau trên các phần mẫu nhỏ của cùng một mẫu.
TCVN 0174	2007	Hard coal and coke. Determination of volatile matter	Tiêu chuẩn này quy định phương pháp xác định hàm lượng chất bốc của than đá và cốc.
TCVN 251	2007	Hard coal. Size analysis by sieving	Tiêu chuẩn này quy định phương pháp chuẩn để phân tích cỡ hạt của than bằng sàng thủ công sử dụng sàng thử nghiệm có kích thước lỗ nằm trong khoảng giữa 125mm và 45 micromet.
TCVN 254-2	2009	Solid mineral. Determination of phosphorus content. Part 2: Reduced molypdophosphate photometric method	Tiêu chuẩn này quy định phương pháp đo màu sau khi khử molypdophotphat để xác định tổng hàm lượng phospho của than đá, linhit và cốc,
TCVN 255	2007	Solid mineral fuels. Determination of carbon and hydrogen. High temperature combustion method	Tiêu chuẩn này quy định phương pháp xác định tổng hàm lượng cacbon và tổng hàm lượng hydro trong than đá, than nâu, than non, và cốc bằng phương pháp đốt ở nhiệt độ cao.
TCVN 1693	2008	Hard coal and coke. Manual sampling	Tiêu chuẩn này quy định các thuật ngữ cơ bản sử dụng trong lấy mẫu thủ công của than đá và cốc và mô tả nguyên tắc chung về lấy mẫu.
TCVN 1790	1999	Coal of Hon Gai. Cam Pha. Technical requirements	Tiêu chuẩn này áp dụng cho các loại than cục và than cám thương phẩm của vùng Hòn Gai Cẩm phả
TCVN 2273	1999	Coal of Mao Khe. Technical requirements	Tiêu chuẩn này áp dụng cho các loại than cục và than cám thương phẩm của mỏ Mạo Khê
TCVN 2279	1999	Coal of Vang Danh. Nam Mau. Technical requirements	Tiêu chuẩn này áp dụng cho các loại than cục và than cám thương phẩm của Khu mỏ Vàng Danh - Nam Mẫu
TCVN 3148	1979	Conveyors. General safety requirements	Qui định các yêu cầu về an toàn cho kết cấu và bố trí băng tải các loại sử dụng trong các ngành kinh tế quốc dân
TCVN 4307	2005	Coal. Method for determination of undersized or oversized proportions	Tiêu chuẩn này quy định phương pháp xác định tỷ lệ dưới cỡ hoặc trên cỡ của một cỡ hạt quy định cho than đá và antraxit.
TCVN 4684	1989	Coal of Naduong. Specifications	Ap dụng cho than thương phẩm Na dương
TCVN 4778	2009	Coal. Determination of bulk density	Tiêu chuẩn này mô tả quy trình hình nón để xác định tỷ khối rời của than đã nghiền có cỡ hạt nhỏ hơn 37mm, cũng như nguyên liệu nạp cho lò luyện cốc.

Number	Rev.	Title	Content
TCVN 4826-1	2007	Solid mineral fuels. Vocabulary. Part 1: Terms relating to coal preparation	Tiêu chuẩn này định nghĩa các thuật ngữ thường dùng trong tuyển than.
TCVN 4914	2007	Coal. Determination of forms of sulfur	Tiêu chuẩn này quy định các phương pháp xác định hàm lượng lưu huỳnh sunfat và lưu huỳnh pirit trong than, bao gồm cả than nâu và than non, và tính lượng lưu huỳnh hữu cơ có trong than.
TCVN 4918	1989	Coal. Determination of mineral matter	Qui định phương pháp xác định lượng vật chất khoáng trong tất cả các loại than, bao gồm cả than nâu và than linhit
TCVN 4920	2007	Solid mineral fuels. Determination of carbonate carbon content. Gravimetric method	Tiêu chuẩn này quy định phương pháp khối lượng xác định cacbon trong cacbonat khoáng liên kết với nhiên liệu khoáng rắn.
TCVN 4921	1989	Brown coals and lignite. Classification based on total moisture content and tar yield	Qui định việc phân loại than theo độ ẩm toàn phần và hàm lượng nhựa áp dụng cho than nâu và linhit kể cả những trường hợp trong điều kiện không tính đến phần tro của than thì nhiệt nóng chảy toàn phần của nó ở trạng thái cân bằng với không khí ở 30oC và độ ẩm tương đối lớn hơn 24000kj/kg
TCVN 5208-1	2008	Cranes. Requirements for mechanisms. Part 1: General	Tiêu chuẩn này quy định các yêu cầu chung cho cơ cấu công tác và bộ phận liên quan của cần trục và các thiết bị nâng được quy định trong ISO 4306-1, ISO 4306-2 và ISO 4306-3.
TCVN 5208-3	2008	Cranes. Requirements for mechanisms. Part 3: Tower cranes	Tiêu chuẩn này quy định các yêu cầu cho cơ cấu công tác và bộ phận liên quan của cần trục tháp, bổ sung vào các yêu cầu chung trong TCVN 5208-1.
TCVN 5208-4	2008	Cranes. Requirements for mechanisms. Part 4: Jib cranes	Tiêu chuẩn này quy định các yêu cầu riêng liên quan đến các cơ cấu của cần trục kiểu cần, được định nghĩa trong ISO 4306-1.
TCVN 5208-5	2008	Cranes. Requirements for mechanisms. Part 5: Bridge and gantry cranes	Tiêu chuẩn này quy định các yêu cầu riêng liên quan đến cơ cấu của cầu trục và cổng trục, được định nghĩa trong ISO 4306-1.
TCVN 5333	1999	Coal of Nui Hong. Specifications	Tiêu chuẩn này áp dụng cho các loại than cám thương phẩm của mỏ Núi Hồng
TCVN 5420	1991	Belt conveyors. Basic parameters and technical requirements	Ap dụng cho băng tải tĩnh tại và di động dùng để vận chuyển vật liệu rời và dạng cục, có mật độ dải đến 3,15 t/m3 và hàng hóa dạng bao kiện
TCVN 5579	1991	Coal. Sampling of exploitation seams	Ap dụng cho than nâu, than đá, antraxit và qui định phương pháp lấy mẫu vỉa khai thác ở các mỏ lộ thiên (hầm, lò)
TCVN 6014	2007	Hard coal. Determination of nitrogen - Semi-micro Kjeldahl method	Tiêu chuẩn này quy định phương pháp xác định hàm lượng nitơ của than đá, than nâu và than non bằng phương pháp Kjeldahl bán vi.
TCVN 6015	2007	Hard coal. Determination of Hardgrove grindability index	Tiêu chuẩn này quy định phương pháp xác định chỉ số nghiền của than đá, sử dung máy Hardgrove. Tiêu chuẩn này cũng quy định quy trình hiệu chuẩn máy thử và cách chuẩn bị mẫu than tiêu chuẩn để so sánh.
TCVN 6257	1997	Hard coal. Determination of moisture holding capacity	Qui định phương pháp xác định độ ẩm lưu trong than đá
TCVN 6258	1997	Standard test method for analysis of	Qui định các phương pháp phân tích nhanh và không tốn kém để phân tích những thành

Number	Rev.	Title	Content
		coal and coke ash	phần chính thường được xác định trong tro của than và cốc
TCVN 6559	1999	Coal of Khanh Hoa. Technical requirements	Tiêu chuẩn này áp dụng cho các loại than cục và than cám thương phẩm của mỏ Khánh Hoà
TCVN 7984	2008	Solid mineral fuels. Determination of total mercury content of coal	Tiêu chuẩn này quy định quy trình xác định tổng số hàm lượng thủy ngân trong than.
TCVN 7985	2008	Solid mineral fuels. Determination of total cadmium content of coal	Tiêu chuẩn này quy định quy trình xác định tổng số hàm lượng cadimi trong than

Chapter-6. Referenced Literature and Materials

The referenced books, literatures, standards to establishing this guide line are organized as follows.

1. Interpretation of technical regulation for thermal power facility(10/Jul/1007): NISA (Nuclear and Industrial Safety Agency) of METI (Ministry of Economy, Trade and Industry)
2. Management of coal storage (No.74: Nov./1962): TENPES (Thermal and Nuclear Engineering Society of Japan)
3. Safety and disaster prevention measures (No.390: Mar./1989): TENPES (Thermal and Nuclear Engineering Society of Japan)
4. Fuel receiving and storage facility (No.516: Sept./1999): TENPES (Thermal and Nuclear Engineering Society of Japan)
5. The outline—boiler (No.583: Apr. 2006): TENPES (Thermal and Nuclear Engineering Society of Japan)
6. Fuels and combustion (first half) (No.588: Sept./2005): TENPES (Thermal and Nuclear Engineering Society of Japan)
7. Fuels and combustion (second half) (No.590: Nov./2005): TENPES (Thermal and Nuclear Engineering Society of Japan)
8. Operation and maintenance of boiler (No.592: Jan. /2005): TENPES (Thermal and Nuclear Engineering Society of Japan)
9. Advances in technology of coal storage facility and disaster management (No.601: Oct./2006): TENPES (Thermal and Nuclear Engineering Society of Japan)
10. Peripherals for conveyor: KANSAI Automation Co., Ltd.