

PROBLEMS OF PREVENTION of Major Industrial Accidents in BRICS Countries: from coal industry to post-industry

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What's at issue?

Major industrial accident is a man-made occurrence in a hazardous production facility with catastrophic consequences or threat of catastrophic consequences (i.e. *irremediable* for the facility itself and/or its environment, and associated with death of people, material damage and/or environmental damage).

«...the term *major accident* means a sudden occurrence - such as a major emission, fire or explosion - in the course of an activity within a major hazard installation, involving one or more hazardous substances and leading to a **serious danger** to workers, the public or the environment, whether *immediate or delayed*”

(C174 Prevention of Major Industrial Accidents Convention, 1993 Part I - Scope and definitions)

Indicators and criteria of “**seriousness**” of occurrence

(The World Bank, The International Federation of Red Cross and Red Crescent Societies, World Health Organization, CRED Emergency Events Database)

To be accounted: local disasters and catastrophes when:

- more than 10 people are killed,
- more than 100 people are injured,
- state of emergency is introduced,
- call for international aid is announced.

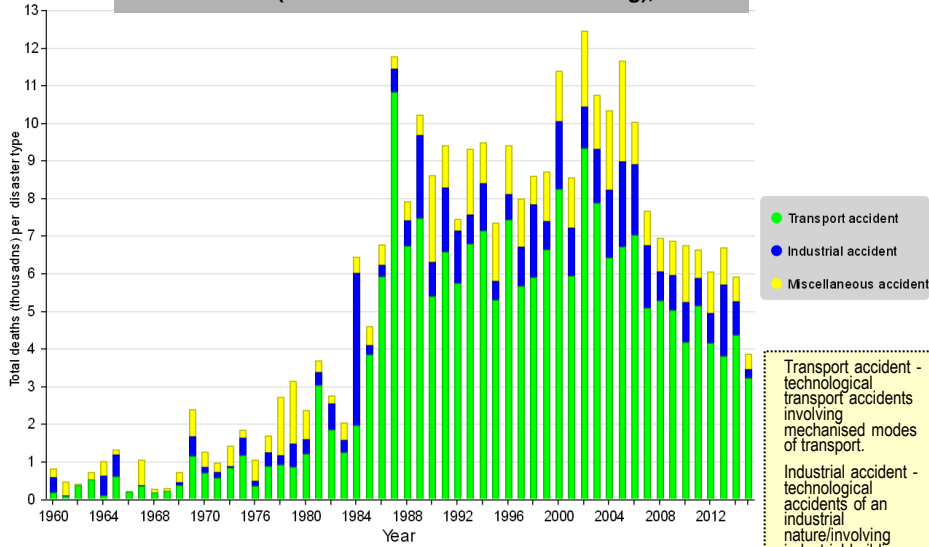


Technological Disasters Worldwide

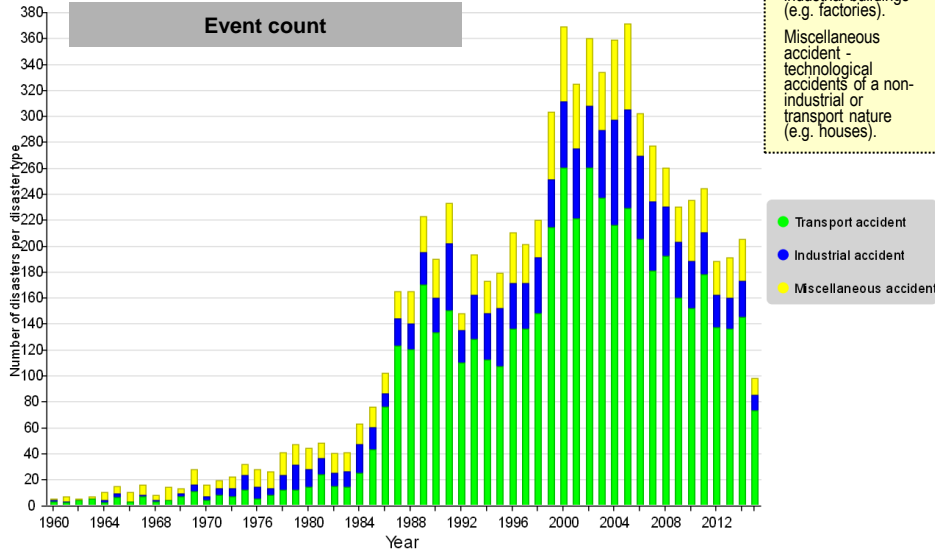
1960 to 2015

(according to EM-DAT: The OFDA/CRED International Disaster Database)

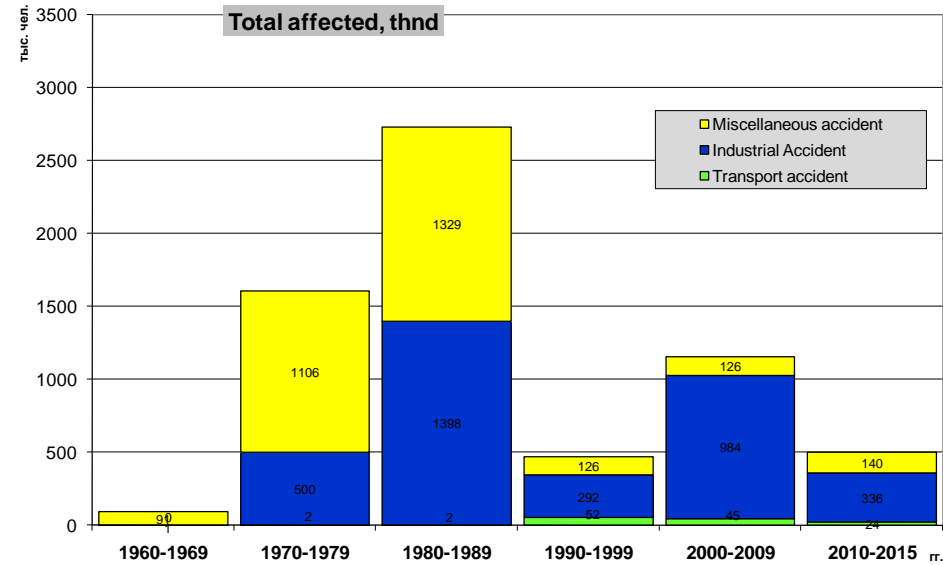
Total death (it is the sum of deaths and missing), thnd



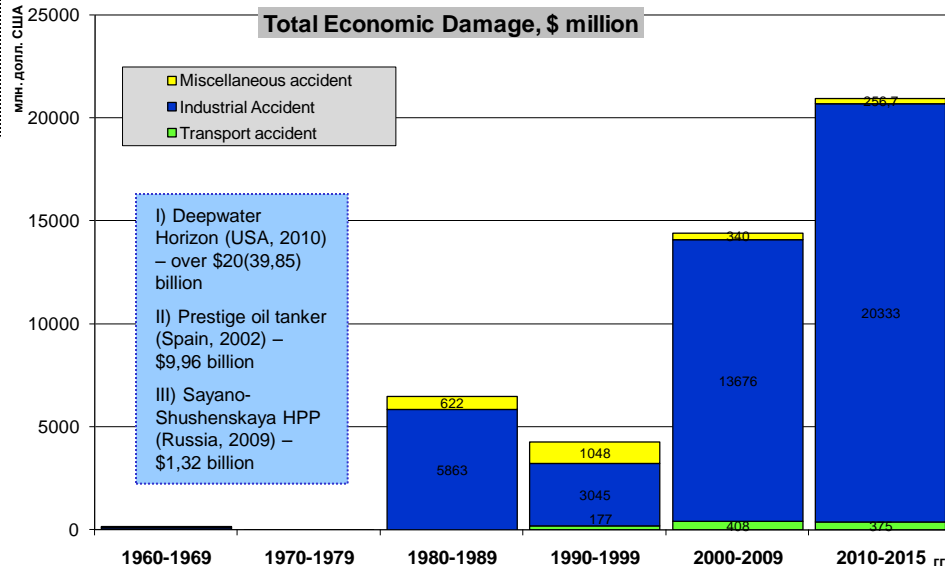
Event count



Total affected, thnd



Total Economic Damage, \$ million





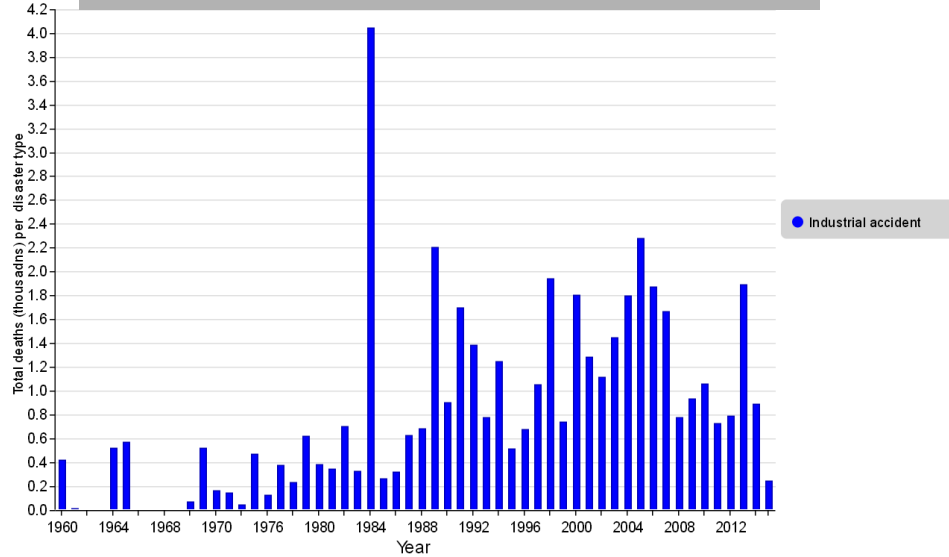
Industrial accident : Worldwide & BRICS

1960 to 2015

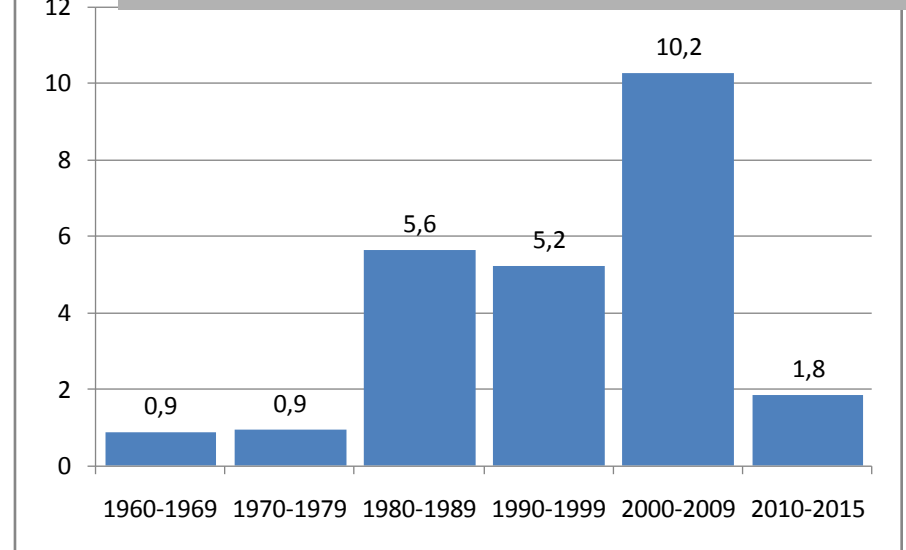
(according to EM-DAT: The OFDA/CRED International Disaster Database)

Industrial accident - technological accidents of an industrial nature/involving industrial buildings (e.g. factories).

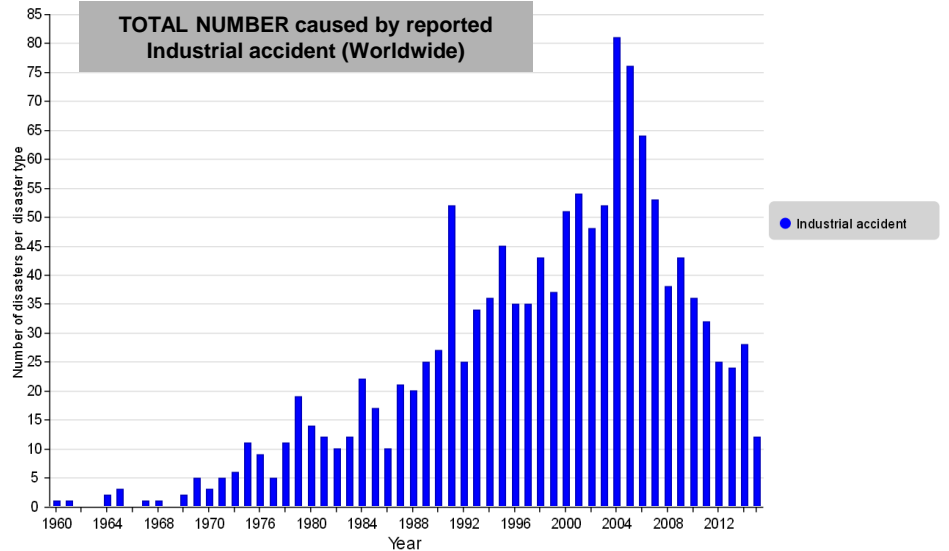
TOTAL DEATHS caused by reported Industrial accident (Worldwide)



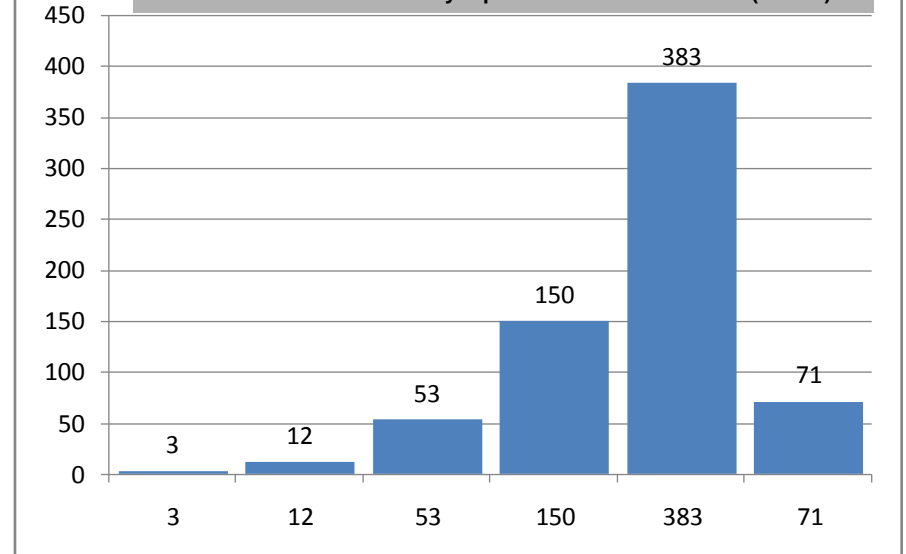
TOTAL DEATHS caused by reported Industrial accident (BRICS) , thousands



TOTAL NUMBER caused by reported Industrial accident (Worldwide)



TOTAL NUMBER caused by reported Industrial accident (BRICS)





Crisis of Industrialism*

Major industrial accidents of the 1970's and 1980's

- **Staten Island** (USA, **1973**, liquefied natural gas fire, **40** deaths),
- **Potchefstroom** (South Africa, **1973**, ammonia leak, **18** deaths),
- **Flixborough** (England, **1974**, cyclohexane explosion, **28** deaths, 89 injured),
- **Decatur** (IL, USA, **1974**, propane explosion, **7** deaths, 152 injured),
- **Beek** (the Netherlands, **1975**, propylene explosion, **14** deaths, 107 injured),
- **Seveso** (Italy, **1976**, toxic contamination due to dioxin release, **30** injured, 220 thousand relocated),
- **Westwego, Galveston, etc.** (USA, December **1977**, 5 dust explosions in 8 days in different grain elevators, **59** deaths, 48 injured)
- **San Carlos** (Spain, **1978**, propylene explosion, **215** deaths),
- **Santa Cruz** (Mexico, **1978**, methane fire, **52** deaths),
- **Ortuella** (Spain, **1980**, propane explosion, **51** deaths),
- **Bhopal** (India, **1984**, methyl isocyanate release, over **2 thousand** deaths, over 200 disabled),
- **San Juan Ixhuatepec** (Mexico City, Mexico, **1984**, liquefied oil gas explosions, **644 deaths**, 7087 injured),
- **Arzamas** (USSR, **1988**, cyclonite explosion, **91** deaths, 1500 injured),
- **Piper Alpha** (the North Sea, **1988**, gas explosion on off-shore oil platform, **167** of 226 killed),
- **Ufa** (USSR, **1989**, explosion of natural gas liquids, **575** deaths, over 600 injured)

*

Industrialism (Modern, Capitalism, Contemporary, Civil society, etc.) is super-ideology of the West, modern Western civilization that emerged on the ruins of traditional Medieval society (in a narrow sense – social system with industry as a major type of economic paradigm)



MIAs – major industrial accidents: From Coal-industry to Post-industry

Man-made disasters are gloomy companions of industrial history of Modern (1700-1917) and Contemporary (1918 to ~1991) periods.

MIAs are precursors of Post-industrialism (~1991 to present) – “Accidents of Modern”

Periods of Industrial Development				
	<i>late</i> Pre-industrialism “water, wood and rock” (before ~ 16 th century)	<i>classical</i> Industrialism “coal and iron” (~16 th to 20 th centuries)	<i>late classical</i> Industrialism “oil and plastic” (late 20 th to early 21 st centuries)	<i>early</i> Post-industrialism “?” (21 st century to ...)
MIA setup by industry	Mining	Coal mining	oil/gas/chemical energy	
Typical examples of well-known MIAs	<ul style="list-style-type: none"> •1376 – collapse of Rammelsberg Mine, Goslar, Germany (> 100 deaths) •1448 – flooding of Heilig-Kreuz-Stollen Mine, Schwaz, Austria (> 260 deaths) • 1565 – collapse of Der Goldene Esel Mine, Zloty Stok, Silesia (> 95 deaths) 	<ul style="list-style-type: none"> •1866 – Oaks, Barnsley, England (361 deaths) •1906 – Courrières, Northern France (1099 deaths) •1907 – Monongah No. 6 & 8, West Virginia, USA (362 deaths) •1942 – Honkeiko, Manchuria, Japan (now China) (1549 deaths) •1963 – Mitsui Miike, Omuta, Kyushu, Japan (458 deaths) 	<ul style="list-style-type: none"> •1978 – San Carlos, Spain, propylene explosion (215 deaths) •1988 – Piper Alpha explosion, the North Sea (167 deaths) •1984 – Bhopal, India, methyl isocyanate release (> 2 thousand deaths) •1989 – Ufa, USSR, liquefied natural gas explosion (575 deaths) 	<ul style="list-style-type: none"> •18.11.2007 – Zasyadko Mine, Donetsk, Ukraine (101 deaths) •17.08.2009 – Sayano-Shushenskaya HPP, Khakassia, Russia (75 deaths) •20.04.2010 – Deepwater Horizon oil rig, Louisiana, USA (11 deaths) • 8-9.05.2010 – Raspadskaya Mine, Kuznetsk Basin, Russia (91 deaths) •13.05.2014 – Soma Mine, Manisa, Turkey (301 deaths)



Examples of Major Coal Industry Accidents from Media

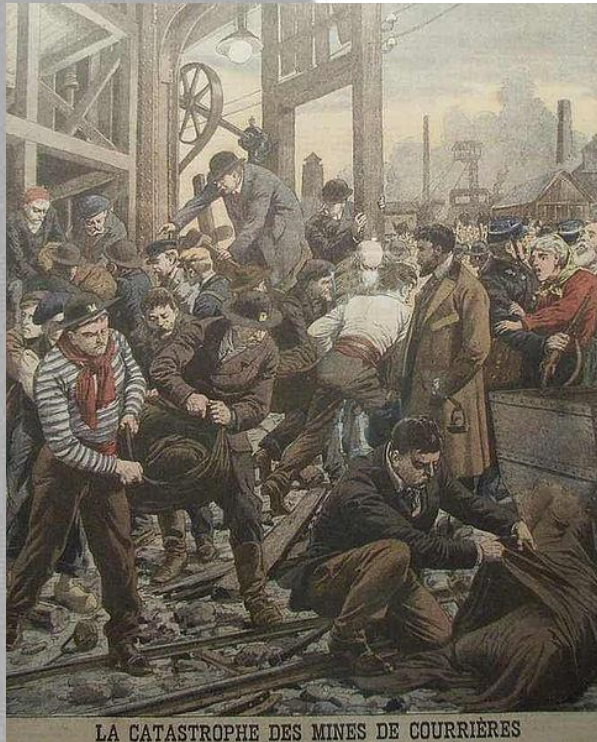
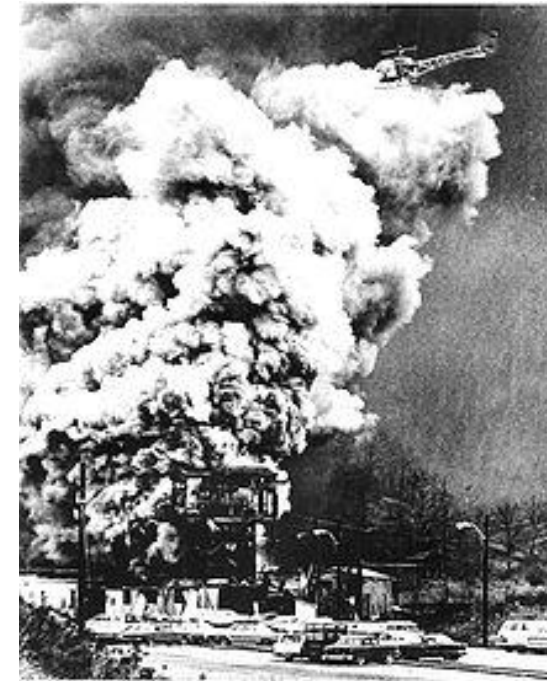


Illustration of consequences of Courrières mining disaster
(Le Petit Journal. Nr. 801. 23. März 1906)



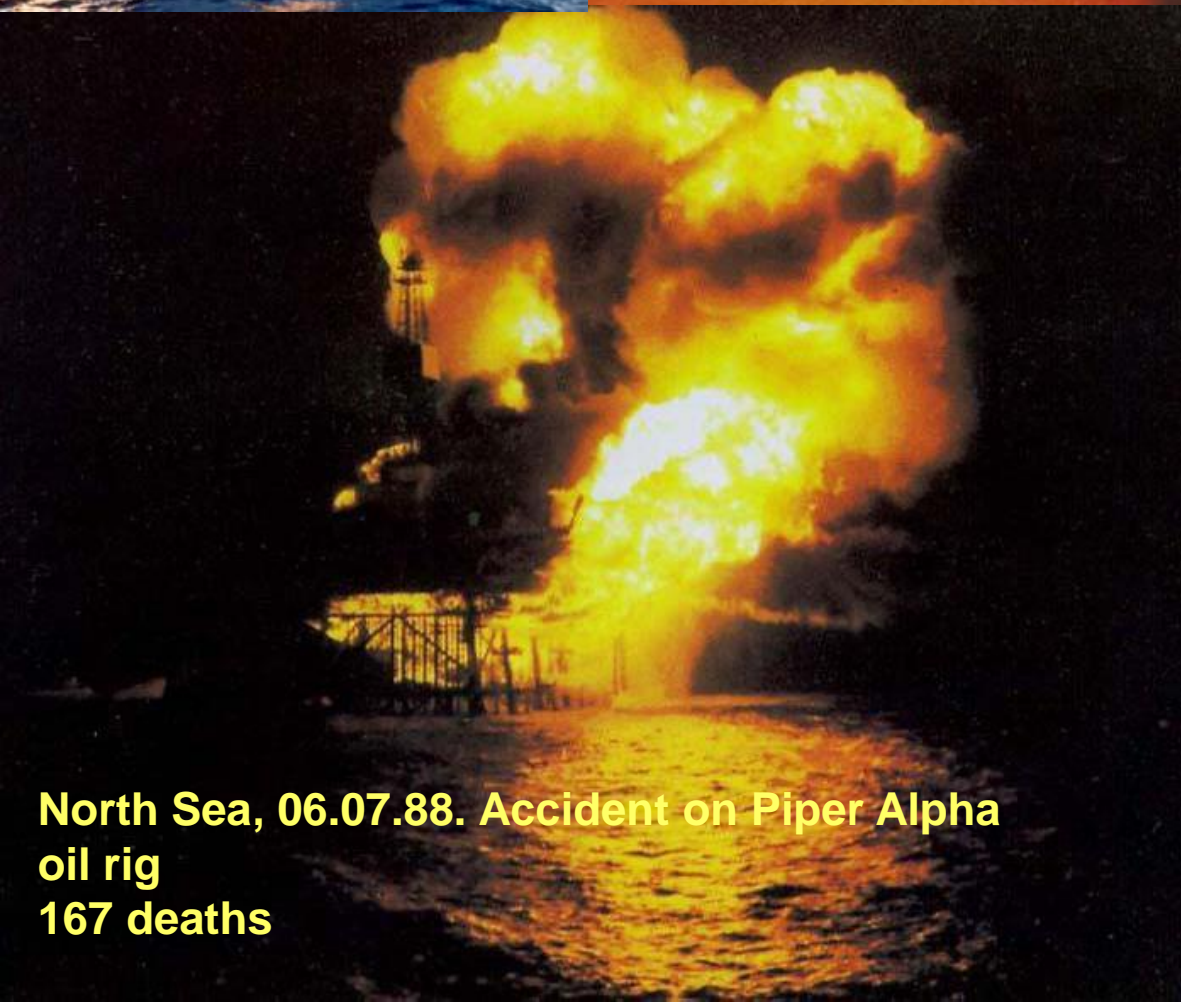
6.12.1907, № 6,8, Monongah, WV, USA, 362 deaths



26.2.1972 Buffalo Creek, Saunders, WV, USA, 114 deaths



PIPER ALPHA, 06.06.1988
First rescue craft



North Sea, 06.07.88. Accident on Piper Alpha
oil rig
167 deaths





Examples of Major Industrial Accidents



June 7, 2001, Norco, Louisiana, USA

World's most massive refinery fire

Capacity – 51 675 m³, 27 500 m³ of gasoline “saved”

The Orion Tank Fire in 2001, world record in tank fire fighting.

Photo courtesy of Industrial Fire World

Hertfordshire, England, December 11, 2005 – worst industrial fire since WWII at the Buncefield oil storage depot . A total of 20 fuel tanks were on fire. 43 people injured. Estimated loss of £750 million.





Examples of Oil Refinery Accidents



March 23, 2005 – Explosion at BP oil refinery in Texas (USA's refinery No. 3): 15 deaths, 170 injured

Puertollano, Spain, August 14, 2003 – Explosion at Repsol-YPF: 3 deaths, 7 seriously injured



Pembroke Refinery, Pembrokeshire, Wales:

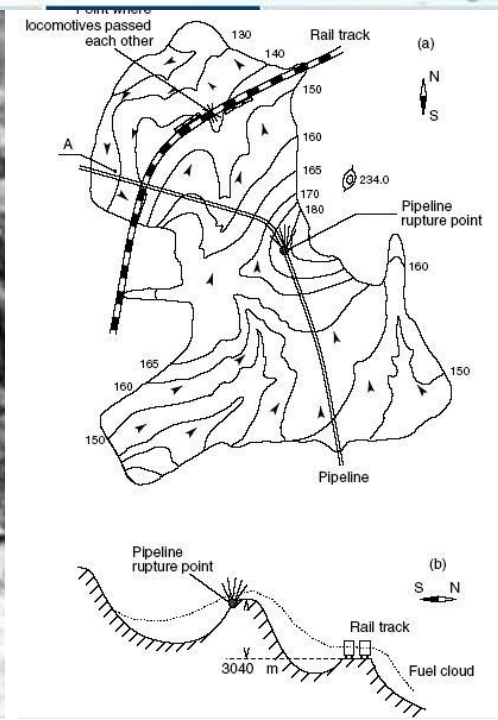
24.07.1994: 26 injured in explosion

15.02.1996: Sea Empress oil tanker ran aground on rocks of St. Ann's Head 6 km away from refinery. 73 tons of crude oil were spilt into the sea – one of the worst environmental disasters in the UK.

24.03.2005: fire on crude oil tank

02.06.2011: explosion of 730 m³ oil tank – 4 deaths, 1 seriously injured.

**Ufa, USSR, June 4, 1989:
Accident on main gas pipe. 1224 killed and
injured. Area covered
with cloud – 2,5 square
kilometers.**



REUTERS /Jose Luis Magana/Greenpeace/Handout
REUTERS/Jose Luis Magana/
Greenpeace/Handout

80 km away from Louisiana Coast, USA, 20.04.2010: explosion on Deepwater Horizon oil rig that caused massive 36-hour fire.

Of 126 persons - 17 injured, 11 missing.

Rig manufactured in 2001, in South Korea, flag of the Marshall Islands флаг, operator – BP. As of September 2009, the deepest well if 10.68 km of which water is 1.26 km. Production of 8 thousand barrels per day. Sank on 22.04.2010.

~ 0.7 to 13.5 thousand tons of oil spilt into the ocean per day.

Release estimate (April 20 to September 19, 2010) – 5 million barrels of oil



Biggest accidents

in Hydro Carbon industry (2010):

Date	Plant type	Even type	Location		Property loss US \$ millions	Fatalities
20/04/2010	Upstream	Fire/ Explosion	Gulf of Mexico	USA	3500*	11
07/07/1988	Upstream	Fire/Explosion	North Sea	UK	1600	165
23/03/2005	Refinery	Fire/ Explosion	Texas	USA	1500	15
11/12/2005	Petroleum	Fire/ Explosion	Hertfordshire	England	1443	0
23/10/1989	Petrochem	Vapour Cloud Explosion	Texas	USA	1300	23
19/03/1989	Upstream	Fire / Explosion	Gulf of Mexico	USA	750	7
12/09/2008	Refinery	Hurricane	Texas	USA	750	0
04/06/2009	Upstream	Collision	North Sea	Norway	750	0
23/08/1991	Upstream	Structural Failure	Sleipner, North Sea	Norway	720	0
15/05/2001	Upstream	Explosion / Fire / Sinking	Campos Basin	Brasil	710	11
25/09/1998	Gas Processing	Vapour Cloud Explosion	Victoria	Australia	680	2
15/04/2003	Upstream	Riot	Escravos	Nigeria	650	No data
24/04/1988	Upstream	Fire	Campos Basin	Brasil	640	0
21/09/2001	Petrochem	Explosion	Toulouse	France	610	30





TOP 20 WORLD PROPERTY DAMAGE LOSSES IN THE HYDROCARBON INDUSTRY — 1974-2013

Rank	Date	Plant type	Event type	Location	Country	Property loss US\$ (Millions)	Fatalites
1	Jul. 7, 1988	Upstream	Explosion/fire	Piper Alpha, North Sea	U.K.	1810	165
2	Oct. 23, 1989	Petrochem	Vapour cloud explosion	Pasadena, Texas	U.S.	1400	23
3	Jan. 19, 2004	Gas processing	Explosion/fire	Skikda	Algeria	940	27
4	Jun. 4, 2009	Upstream	Collision	Norwegian Sector	North Sea	840	
5	Mar. 19, 1989	Upstream	Explosion/fire	Gulf of Mexico	U.S.	830	7
6	Jun. 25, 2000	Refinery	Explosion/fire	Mina Al-Ahmadi	Kuwait	820	5
7	May 15, 2001	Upstream	Explosion/fire/sinking	Campos Basin	Brasil	790	11
8	Sep. 25, 1998	Gas processing	Explosion	Longford, Victoria	Australia	750	2
9	Apr. 24, 1988	Upstream	Blowout	Enchova, Campos Basin	Brazil	700	0
10	Sep. 21, 2001	Petrochemical	Explosion	Toulouse	France	680	30
11	May 4, 1988	Petrochemical	Explosion	Henderson, Nevada	U.S.	640	2
12	May 5, 1988	Refinery	Vapour cloud explosion	Norco, Louisiana	U.S.	610	
13	Mar. 11, 2011	Refinery	Earthquake (3)	Sendai	Japan	600	
14	Apr. 21, 2010	Upstream	Blowout/explosion/fire	Gulf of Mexico	U.S.	600	11
15	Sep. 12, 2008	Refinery	Hurricane	Texas	U.S.	550	
16	Jun. 13, 2013	Petrochemical	Explosion/fire	Geismar, Louisiana	U.S.	510	2
17	Apr. 2, 2013	Refinery	Flooding/fire	La Plata, Ensenada	Argentina	500	0
18	Dec. 25, 1997	Gas processing	Explosion/fire	Bintulu, Sarawak	Malaysia	490	0
19	Jul. 27, 2005	Upstream	Collision/fire	Mumbai High North Field	India	480	22
20	Nov. 14, 1987	Petrochemical	Vapour cloud explosion	Pampa, Texas	USA	480	

(1) Property damage, debris removal and clean-up costs. (2) Inflated to December 2013 values. (3) Loss to refinery following the Tohoku earthquake. (4) Preliminary. Source: Energy Practice, Marsh & McLennan Companies.



Brief Flashback to Fatal Coal Disasters

Coal is energy basis of industrialization in the 18th to 20th centuries.

Coal mining is a source of the first MIAs. (Coal Mining disasters)

First mentions of multiple deaths of miners:

- **October 3, 1705** – explosion of Gateshead (Stony Flatt) mine in Northern England – 30 deaths
- **August 18, 1708** – explosion of Fatfield mine in Durham County – 69 deaths
- **May 25, 1812** – Felling Colliery near Gateshead – 92 miners killed
(30 children and teenagers 8 to 16 years old)

Date of accident	Coal mine, location, country	Number of deaths
1835 18 January	Wallsend, Northumberland, England	102
1867 1 July	Neue Fundgrube, Lugau, Saxony, Germany	101
1869 6 September	Avondale, Plymouth, Pennsylvania, USA	110
1885 5 March	Jan, Karvina, Czechia	108
1887 3 May	Mine No. 1, Nanaimo, Vancouver Island, British Columbia, Canada	150

Date of accident	Coal mine, location, country	Number of deaths
1862 16 January	Hartley Colliery, Northumberland, England	204
1869 2 August	Freiherrlich von Burgker Coaln und Eisenhüttenwerke, Fretal, Saxony, Germany	276
1866 12 December	Oaks Colliery, Barnsley, England	361
1913 14 October	Universal Colliery Senghenydd, Wales	439
1906 10 March	Courrières, Nord-Pas-de-Calais, France	1099

Major* accidents in the world's coal mining

in Modern and Contemporary industrial periods (1705 to 2014)

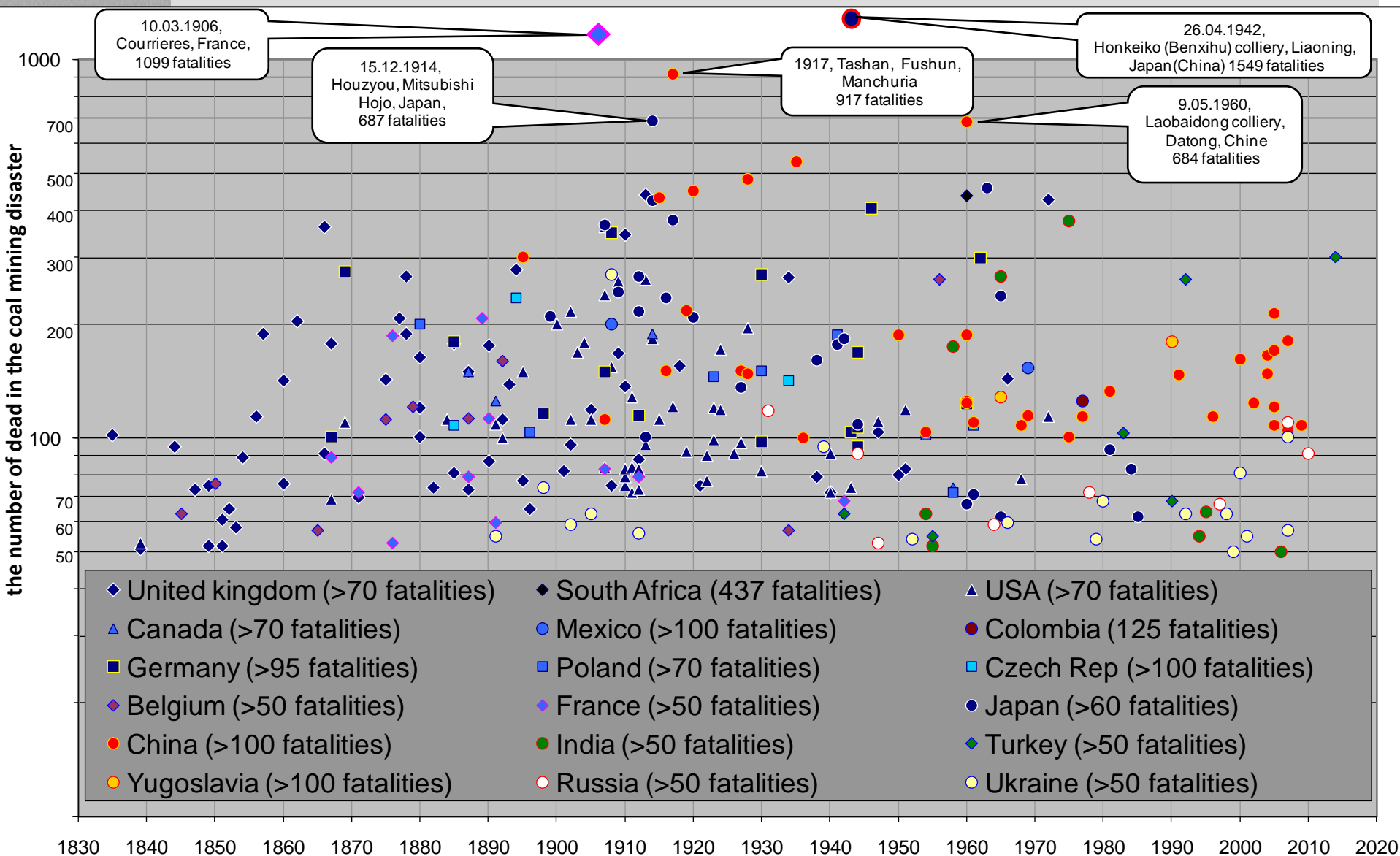
* Especially significant accidents after 1861 with over 200 deaths, in 1708 to 1860 – first known major accidents with over 50 and 100 deaths in the UK and the USA. Based on publicly available sources

№	Number of deaths	Date	Coal mine, country	№	Number of deaths	Date	Coal mine, country	№	Number of deaths	Date	Coal mine, country
1	30 ¹⁾	1705 3 October	Stony Flatt, England	21	239	1907 19 December	Darr, USA	41	482	1928	Fushun, China
2	69 ²⁾	1708 18 August	Fatfield, England	22	200	1908 27 February	Mina Rosita Vieja, Mexico	42	271	1930 21 November	Grube Anna, Germany
3	102 ³⁾	18 January	Wallsend, England	23	271	1908 18 June	Makariev (Rykov) Mine, Novorossiya, Russian Empire	43	265	1934 22 September	Gresford Colliery, Wales
4	53 ²⁾	1839 18 March	Black Heath Coal, USA	24	348	1908 12 November	Zeche Radbod Schacht ½, Germany	44	536	1935	Zichuan, Китай
5	204	1862 16 January	Hartley Colliery, England	25	243	1909 5 August	Onoura, Japan	45	1549	1942 26 April	Honkeiko (Benxihu) Colliery, China
6	361	1866 12 December	Oaks Colliery, England	26	259	1909 13 November	Cherry mine, USA	46	405	1946 20 February	Zeche Monopol Schacht Grimberg ¾, West Germany
7	276	1869 2 August	Freiherrlich von Burgker Coaln und Eisenhüttenwerke, Germany	27	344	1910 21 December	Pretoria Pit, England	47	262	1956 8 August	Bois du Cazier (Puits Saint-Charles) colliery, Belgium
8	207	1877 22 October	Blantyre, Scotland	28	267	1912 November	Yubari, Japan	48	684	1960 9 May	Laobaidong colliery, China
9	268	1878 11 September	Prince of Wales, Wales	29	216	1912 December	Yubari, Japan	49	437	1960 21 January	Coalbrook, South Africa
10	200	1880	Renard, Poland	30	439	1913 14 October	Universal Colliery, Wales	50	299	1962 7 February	Luisenthal, West Germany
11	207	1889 3 July	Verpilleux, France	31	263	1913 22 October	Stag Canyon No. 2, USA	51	458	1963 9 November	Mitsui Miike, Japan
12	235	1894 14 June	Larisch, Czechia	32	423	1914 28 November	New Yubari, Japan	52	268	1965 28 May	Dhori colliery, India
13	278	1894 25 June	Colliery Cilfynydd, Wales	33	687	1914 15 December	Houzyou, Mitsubishi Hojo, Japan	53	237	1965 1 June	Chikuho Yamano, Japan
14	+300	1895	Zhongxing, China	34	432	1915	Zhongxing, China	54	427	1972 6 June	Wankie Colliery, Rhodesia (Zimbabwe)
15	210	1899 15 June	Hokoku, Japan	35	235	1916	Taisyuu, Japan	55	375	1975 27 December	Chasnala Sudamdih Colliery, India
16	200	1900 1 May	Winter Quarters 1 & 4, USA	36	376	1917 21 December	Onoura, Japan	56	263	1992 3 March	Incirharmani, Turkey
17	216	1902 19 May	Fraterville, USA	37	917	1917	Tashan, Manchuria	57	214	2005 15 February	Sunjiawan, China
18	1099	1906 10 March	Courrières, France	38	217	1919	Benxihu, China	58	301	2014 13 May	Soma, Turkey
19	365	1907 20 July	Hokoku, Japan	39	451	1920	Kailuan, China				
20	362	1907 6 December	Monongah No. 6 & 8, USA	40	209	1920	Yubari, Japan				

- 1) First known major coal mining accident in modern period;
- 2) First known major coal mining accident in the UK and the USA with over 50 deaths;
- 3) First known major coal mining accident in the UK with over 100 deaths.

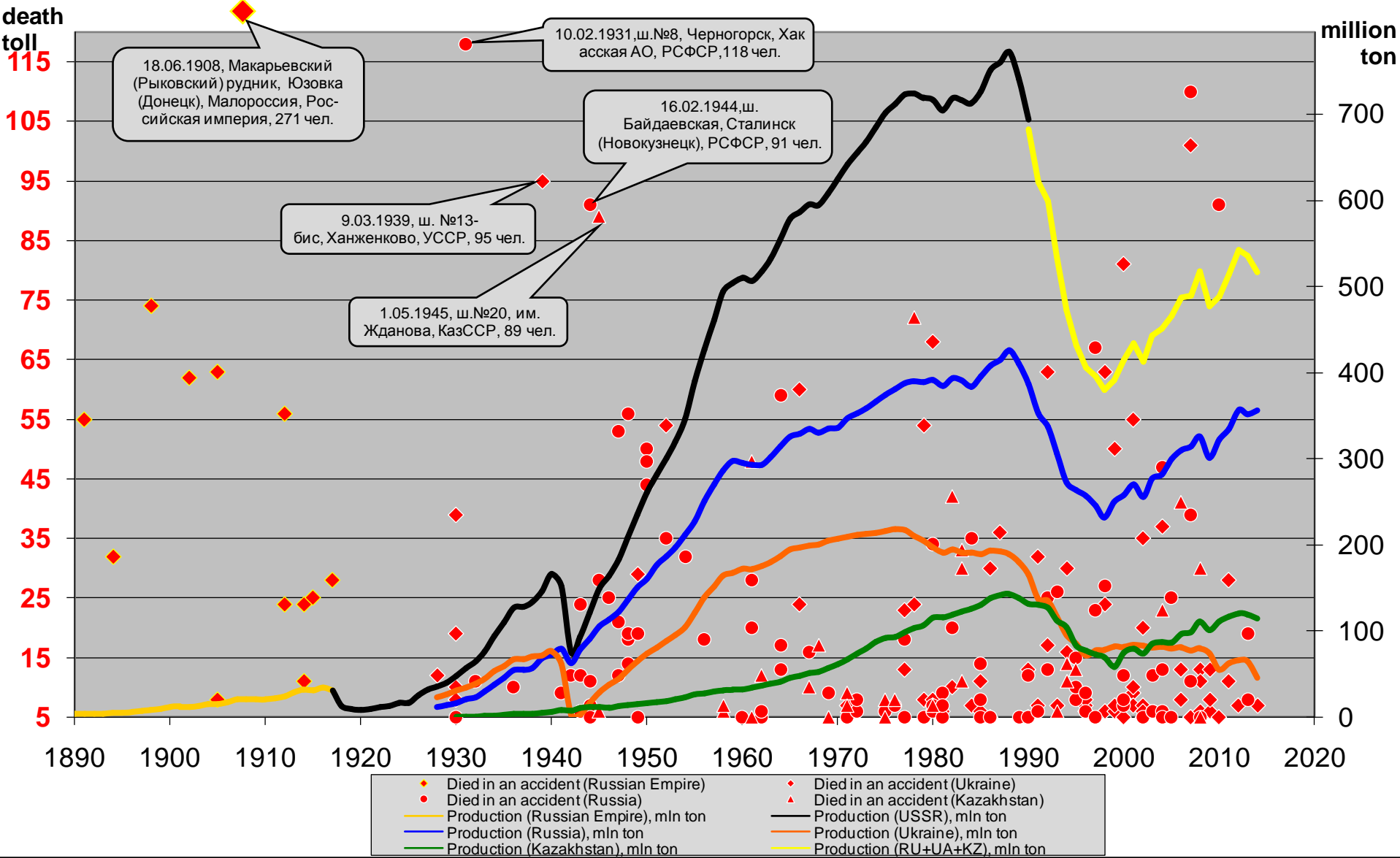


Biggest Coal Mining Disasters: industrial periods - Modern (1835-1917) and Contemporary (1918-2014)





Coal Production and Accidents in Mines of Russian Empire, USSR, Russian Federation, Ukraine and Kazakhstan





Coal Mining Countries in 19th to 21st Centuries:

total coal production, number of lethal disasters in mines, and number of deaths

A country, territory of the country (in order of duration of industrial coal mining)	The period of active industrial mining		Coal production, bln tons			The seriousness of the accident, the death toll more	The number of known fatal accidents	The number of dead in this accident
	Duration years	Years	Total	mining including:				
				underground	strip			
United Kingdom	300	1 700 -2000	20.3	19.5	0.8	>60 >100 >200 >300 >400	56 29 8 3 1	7487 5390 2366 1114 439
United States of America	180	1830- 2010	68.6	42.3	26.3	>25 >60 >100 >200 >300 >400	123 54 26 1 1	8968 6354 4159 362 362
Germany	150	1860- 2010	33.7	8.8 *	24.9 **	>95 >200 >300 >400	16 5 2 1	2597 1599 753 405
Poland	130	1880- 2010	12.5	10.1 *	2.4 **	>25 >60 >100 >200	15 7 6 1	1222 961 889 200
Russian Empire, Soviet Union, Russian Federation, Ukraine, Kazakhstan	120	1890- 2010	36.3	24.6	11.7	>25 >60 >100 >200	54 17 4 1	2950 1550 600 600
Japan	90	1900- 1990	2.6	2.6	n / a	>60 >100 >200 >300 >400 >600	24 18 12 5 3 1	5231 4793 3926 2309 1568 687
Republic of Turkey	87	1923- 2010	2.1	0.4 *	1.7 **	>25 >60 >100 >200	7 3 2 1	592 429 366 263
Republic of India	63	1947- 2010	11.1	-	-	>25 >60 >100 >200 >300	11 5 3 1 1	1200 945 818 375 375
People's Republic of China	61	1949- 2010	50.7	48.5 *	2.2 **	>100 >200 >300 >600	25 1 1 1	3957 3957 3957 684

* - Total extraction of coal (as a rule, production by underground mining)

** - The total production of lignite (usually production by strip mine)



Lessons Learnt from Major Industrial Accidents (**MIAs**) of Industrialism Crisis – late 20th to early 21st centuries.

Problems of prevention MIAs in BRICS

Major Industrial Accidents (**MIAs**) - a heavy blow to the reputation of sustainable industrial development.

Blackmail labeling «technology failing state»

MIAs significantly alter the trajectory of industrial development.

Until the freezing of individual technologies and even industrial sectors

Risk Analysis - a modern methods for recognizing threats **MIAs**.

Actualization "hazardmap" of industrial accidents in the BRICS countries

The problem of preventing the **MIAs** must be addressed joint scientific and technological strength of the BRICS

Development and adoption «roadmap of prevention **MIAs**» to ensure the safety of industrial growth in the BRICS countries

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