



三门核电有限公司
Sanmen Nuclear Power Co., Ltd.

追求卓越 超越自我

Understanding and Thinking about the Role of Collective Dose Concept in Radiation Protection Management of Nuclear Power Plants

Wang Chuan¹, He Junnan², Zhang Qiang², Zeng Jinzhong², Ni Wei², Wang Ruijun²,
Li Houwen²

1. CNNC Sanmen Nuclear Power Co, Ltd China ;

2. CNNC Nuclear Power Operations Management Co, Ltd, China

OCT.,22, 2019

Introduction

Collective dose is a sole indicator concerning radiation protection(RP) in WANO performance indicators system to evaluate the performance of nuclear power plant(NPP).

Operation utilities and regulatory bodies regard the collective dose as the most important indicator to evaluate RP performance of NPP, even as a sole one.

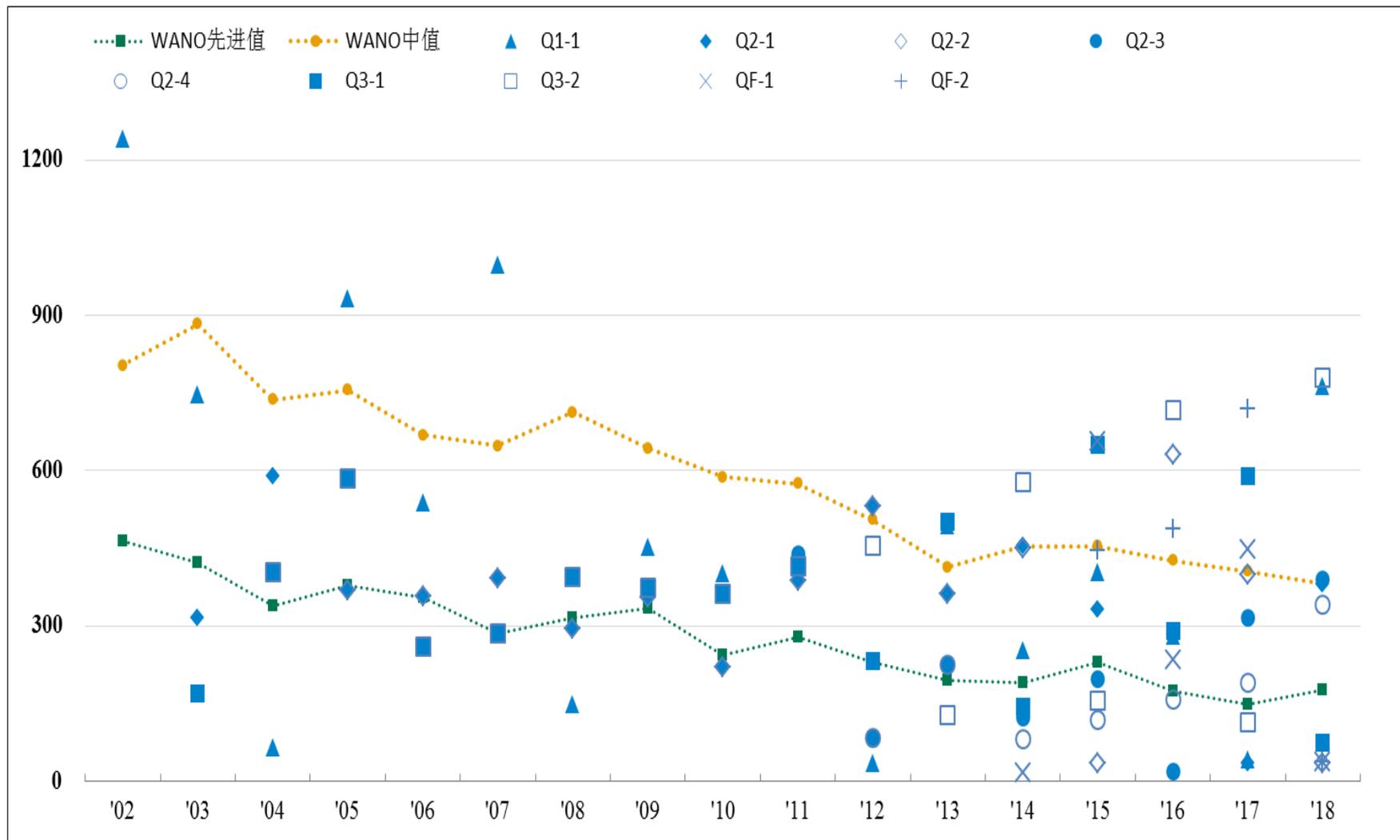
How to evaluate RP performance of NPP in all its aspect?

Dose the absolute value of collective dose mean the good or bad of RP management of NPP?

Annual collective dose of 9 units in Qinshan NPP (man.mSv)

Year	Q1-1	Q2-1	Q2-2	Q2-3	Q2-4	Q3-1	Q3-2	QF-1	QF-2	WANO M.V.	WANO B.Q.
2002	1241	/	/	/	/	/	/	/	/	803	465
2003	746	317	/	/	/	171	/	/	/	883	422
2004	64	590	/	/	/	405	405	/	/	737	340
2005	932	369	369	/	/	586	586	/	/	756	379
2006	538	357	357	/	/	259	259	/	/	669	356
2007	997	393	393	/	/	286	286	/	/	648	285
2008	149	294	294	/	/	394	394	/	/	713	315
2009	453	355	355	/	/	374	374	/	/	644	335
2010	401	220	220	19	/	364	364	/	/	588	245
2011	421	389	389	439	/	416	416	/	/	575	278
2012	36	531	531	84	84	233	456	/	/	506	229
2013	495	362	362	226	226	502	128	/	/	414	195
2014	253	455	450	123	82	143	578	16	/	454	191
2015	405	332	35	197	119	649	155	657	445	454	230
2016	281	283	631	20	157	291	718	235	488	427	175
2017	42	34	399	317	190	589	113	447	721	406	149
2018	764	382	36	389	342	75	780	37	37	383	177

Refueling outage is not performed in the year of Annual collective dose below 100 man.mSv.
M.V.: medium value, B.Q.: best quarter



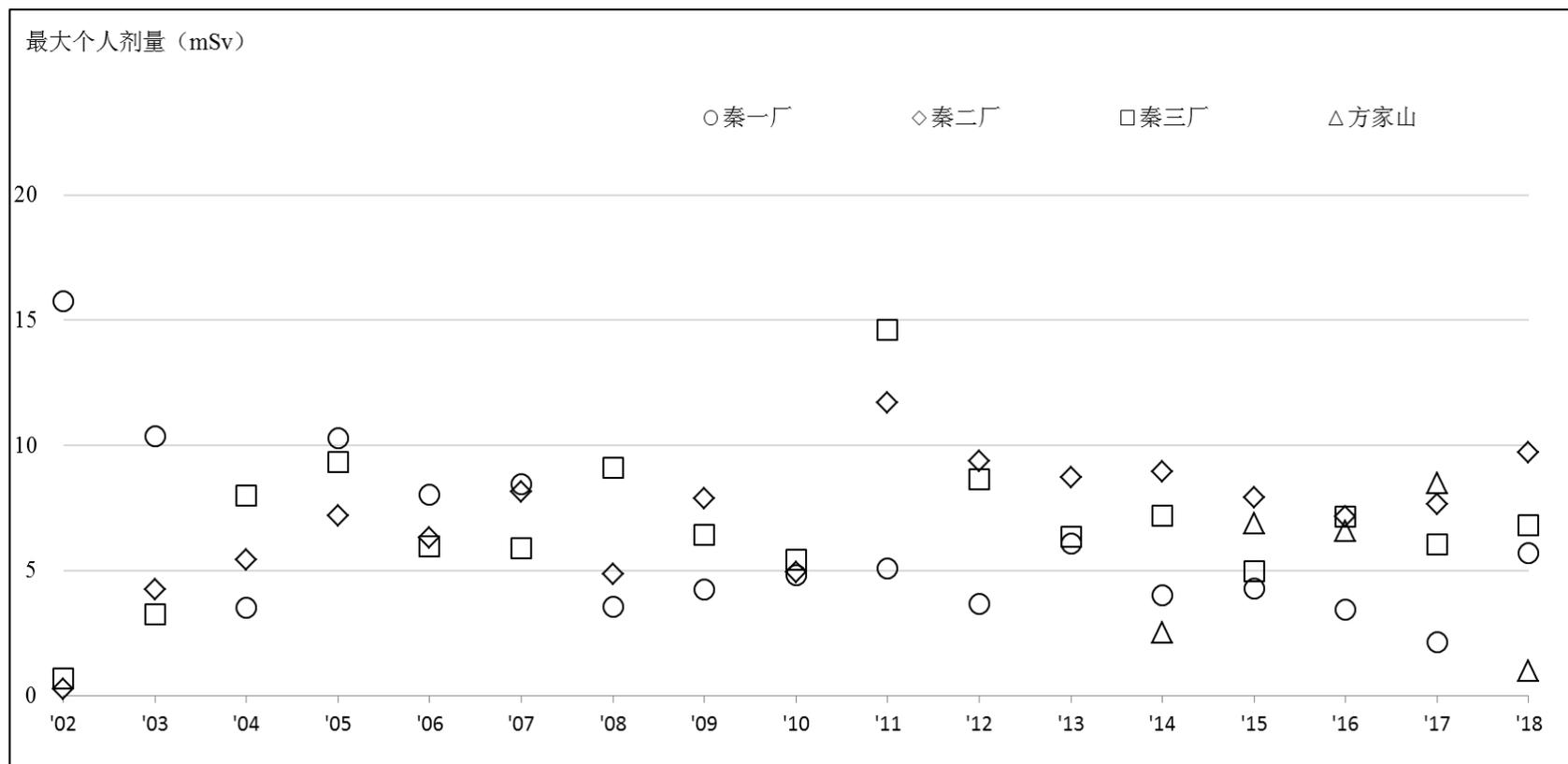


Generally, for 9 units in Qinshan NPP, before 2012, the annual collective dose is between the WANO medium value and best quarter. In some years, the collective dose is below WANO best quarter. But after year 2012, the annual collective dose is higher than the WANO best quarter in the year when the refueling outage is performed, even higher than the WANO medium value

Annual max. individual dose of 9 units in Qinshan NPP (mSv)

Year	Sub Plant 1	Sub Plant 2	Sub Plant 3	Fangjiashan
2002	15.760	0.260	0.692	/
2003	10.370	4.242	3.274	/
2004	3.530	5.443	8.015	/
2005	10.300	7.210	9.350	/
2006	8.050	6.318	5.990	/
2007	8.450	8.164	5.900	/
2008	3.577	4.881	9.102	/
2009	4.257	7.899	6.415	/
2010	4.814	4.946	5.431	/
2011	5.106	11.707	14.637	/
2012	3.681	9.389	8.661	/
2013	6.073	8.726	6.362	/
2014	4.035	8.948	7.192	2.528
2015	4.278	7.914	4.964	6.904
2016	3.439	7.171	7.167	6.595
2017	2.135	7.639	6.033	8.503
2018	5.687	9.730	6.801	0.984

Annual max. individual dose is for plant , not for unit.



Except a few years, the most of annual max. individual doses are below 10mSv.

Individual dose distribution of year 2018 in Qinshan NPP

Number of radiation workers

Plant	<0.5mSv	0.5-1mSv	1-2mSv	2-5mSv	>5mSv	Total
Sub Plant 1	2381	181	146	93	4	2805
Sub Plant 2	3302	260	214	107	16	3899
Sub Plant 3	1924	224	143	103	14	2408
Fangjiashan	2151	16	0	0	0	2167

percentage

Plant	<0.5mSv	0.5-1mSv	1-2mSv	2-5mSv	>5mSv	Total
Sub Plant 1	84.9	6.5	5.2	3.3	0.1	100
Sub Plant 2	84.7	6.7	5.5	2.7	0.4	100
Sub Plant 3	79.9	9.3	5.9	4.3	0.6	100
Fangjiashan	99.3	0.7	0	0	0	100

Except fangjiashan plant, refueling outage is performed in the other plants in 2018. The individual dose distribution of other years is almost the same as that of 2018.

The individual dose of more than 90% radiation workers is below 1mSv.

Average collective dose per unit of operating reactors in some countries in 2017
From ISOE annual report 2017

country	Number of operating reactors	Average collective dose per unit (man.mSv)
China	37	391
France	58	610
USA	99	648
Russian	18	495
Korea, republic of	25	301
Japan	42	129
Germany	8	257

The duration and collective dose of USA PWR
refueling outage in 2017
From ISOE website

	Duration(day)	Collective dose (man.mSv)
Average	29	493
Max.	76	1301
Min.	12	202

The duration and collective dose of all refueling outages in Qinshan NPP

	Duration(day)	Collective dose(man.mSv)
Average	43	375
Max.	89	810
Min.	21	66



General analysis

Based on the data in recent years, both in Qinshan NPPs and overseas NPPs, we can know that the collective dose of that year could hardly be below the WANO best quarter once the refueling outage is performed in the year.

Collective dose is mainly decided by radiation level of worksite and workload. For a NPP with over 10 years operation and mature management model, it is very difficult to decrease the collective dose significantly if the new technology is not adopted, for example, maintenance strategy improvement.

In Qinshan NPP, from 2002, the most of annual Max. individual dose is below 10mSv. The Max. is 15.76mSv. Generally, the annual Max. individual dose is well below the national limit.

In Qinshan NPP, the radiation exposure to more than 90% radiation workers is below 1mSv.

Generally, the exposure to radiation workers is at a low level.

Conclusions and suggestions

On the basis of individual dose well below the national limit and radiation safety of workers enough guaranteed, it is not necessary to decrease the collective dose excessively. For example, in some NPPs, it is required to decrease the collective dose year by year or the goal is set that in the some future years, the collective dose should be below the WANO best quarter even the best one tenth. It is unreasonable or wrong to regard the collective dose as a sole index to evaluate the RP performance of NPP, even if the collective dose is very important.

Conclusions and suggestions

Controlling the radiation dose is not the sole aim of RP management of NPP, furthermore, it is also very important to control the radioactive contamination and to manage the radioactive material.

Both the operation utilities and regulatory bodies should evaluate the RP management of NPP comprehensively, taking into account of radiation dose control, radioactive contamination control and radioactive material management.

It is not meaningful to compare the absolute value of collective dose with a significant difference of technical background.



Thank you for your attention.
Any comments?



三门核电有限公司
Sanmen Nuclear Power Co., Ltd.

中国核电 国家名片

