Summary of major responses to the RFI (classified into items and categories) [Topic 5 : Management measures to block groundwater from flowing into the site]

Particularly-Requested Technologies for Contaminated Water Issues		Response to the RFI			Trend of technical information in the responces	Expert Review Panel's Comments
item	Sub item	Category	No.	Keywords		
(1)Impermeable wall	Clay-type (diaphragm wall)	clay	228, 350, 547, 564, 581, 599	Clay	Required technologies for an impermeable wall are for the O.P. +10m mountain side (at the level of reactor buildings) or for the O.P. +35m in addition to the current drastic measures (ice wall etc.). There are many proposals for impermeable walls (continuous type) made of many types of materials, i.e. clay, cement (soil cement), steel, concrete and others with many results achieved in the construction field. Remote controlled equipment for steel type diaphram wall, which generally requires relatively large equipment for instllation, was proposed. In regards to the location for the installation of walls, there are a number of proposals to install them at the foot of the slope or on the slope for the O.P. +10m. On the other hand, in regards to the installation at the O.P. +35m, there were proposals to install the wall in front of or behind the underground bypass, whereas there are proposals to have the wall installed near the site boundary. There is another proposal to surround the bottom of the tank with impermeable walls as a prevention of water leak from the tanks. In regards to the depth of the wall, there are many proposals to install deeply in order to penetrate into the two permeable layers for both of 10m and 35m.	In regards to impermeable walls, proposals were mostly about conventional technologies both domestic and overseas with a few innovative ideas. We will select a suitable method in the proposal once the additional wall plan and location are decided. Understanding of the ground water behavior is the most important subject to decide the location of the wall. Comprehensively examining the relation between planned activities and ongoing countermeasures (ice wall etc.), a decision should be made after clarifying the potential impact and risk of each additional countermeasure. The following points shall be taken into account in the decision process. After installation of the wall, water level at the upstream side of the wall may increase and overflow may occur. On the other hand, supply of water will be eliminated at the downstream side and it may result in land subsidence and intrusion of seawater. In the case of installation of the impermeable wall in the soil contamination area, construction method should be evaluated and implemented carefully in order to prevent increase of the contaminated area. Monitoring system is required to make immediate actions if performance of the countermeasures is not as the predicted. Proposals of comprehensive countermeasures are from several societies which take neutral positions, and it will be useful to take them into consideration. International experiences to be drawn down in this area are significant. There is a case study of Dounreay shaft which stores radioactive wastes.
		asphalt	704	Asphalt mastic		
		slurry	186	Slurry wall		
		element technology	105, 601	High-specific-gravity material preventing leakage, High performance bentonite		
	Cement-type	soil cement	134, 145, 185, 648, 673, 520, 776	Soil cement, Application of underground dam, etc.		
	Steel-type	sheet pile	29, 444, 480, 523, 726	Sheet piling		
		steel pipe sheeting	53, 110, 681, 469	Steel pipe sheeting, Joint method, Wall with treatment system		
		steel pile	469	Remote control		
		element technology	488	Water stoppage at the joint		
	Concrete-type	concrete wall	51, 143, 380	Surrounding the side and bottom of building, Wall at the mountain side etc.,		
		concrete pile	500	Concrete pile		
		element technology	242	High performance concrete by sea water		
	Injection type	material	241	Slag (with water)	In regards to the walls by injection method, there are many proposals of walls made of cement, water-glass, and polymer which have many results in construction field. Besides this, there are proposals which employ solidification technology for radioactive wastes and self-sealing material. Case example of impermeable walls by injection method (Dounreay Shaft) has been introduced. There are also proposals classified to "the water stoppage technologies from outside the building (Topic 4)". There is a proposal from the Japan Concrete Institute(JCI) about impermeable walls by the injection method at the 35m. Regarding the permanent water stoppage, JCI proposed impermeable walls by concrete. There have been many proposals on comprehensive measures. There are proposals from the Japan Society of Civil Engineers and the Japanese Geotechnical Society, for enclosing the plant area with impermeable walls, and add multilayered measures by the combination of clay-type impermeable walls and dewatering of ground water.	
			442	Slag		
			607	Calcium sulfate(for ice wall)		
		method	62, 627, 299	Cement type, Ultrafine particle cement, Water glass type		
			93, 418, 441	Polymer grout application of solidification method for waste material, Self-sealing wall		
			313	Application of Oil & Gas technology		
			600	Double-pipe and double-packer construction method		
		case study	38, 314	Dounreay Shaft		
	Other type	ground freezing	683	Job record		
		other material	90	Waterproof composite material with fiber		
	Other	comprehensive countermeasures	281	Comprehensive countermeasures (general)	Other proposals are as follows; monitoring leakage through the impermeable wall by optical fiber, effective construction method on the slope, drain materials, etc.	
			107, 134, 564, 648, 672, 673, 676	Comprehensive countermeasures (actual site)		
		various type walls	528, 341	Comparison of wall type		
		element technology	284, 706	Monitoring system for flow and amount of leakage with optical fiber, Welding technology of water impermeable sheet		
			141, 455	Drain sheet		
			705	Construction on the slope		
		concept proposal	96, 405, 541, 765	Impermeable wall - cum - underground trench near the boundary, Impermeable wall outside the boundary, Impermeable wall surrounding the tank area, access by tunnel		
			60, 113, 529, 476	Double trench method, Power saving, management of water level inside and outside the building		

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(2)Covering (capping)	method		89, 342, 708	Bentonite	Many materials for ground covering (capping) were proposed using bentonite, asphalt and organics which have many results in Japan. As for construction method, there are many proposals of conventional ones such as spraying and sheet, whereas spraying from the air by helicopter etc. was also proposed. As a proposal for the covering area, there are several type of proposals, i.e. covering the entirety of the mountain side, all plant areas where No. 1 to No. 6 are located and so on. Also, installation of roof above the contaminated water tanks was also proposed. We have received some suggestion that in the case of covering the entire area, drainage system of surface water should be prepared and possibility of immediate runoff of contaminated water should be considered in the case of leakage events from the tanks happened.	In evaluation of the proposed technologies, it is important to give higher priority to the methods to be able to launched immediately, even if they are not the best. Whichever technologies are implemented, it is required that problems will not be the fatal if they will occur by construction and reconsideration and back tracking shall be possible if required. In comparison with construction in underground, construction on the ground surface is expected to satisfy the above conditions. Facing (capping) of ground and installation of drainage system for rainwater are examples. If considering low efficiency of work in the period of rainy – summer – typhoon seasons, we should implement facing and improvement of drainage immediately, and complete them before the next rainy season. These measure will prevent rainwater from recharging into ground water and it is thought that it can reduce the risk of increase the contaminated water. Considering the large amount of precipitation in recent years, it is also useful as a measure for rainfall. Innovative controls (other than large-scale facing /capping) to reduce water infiltration should be considered. These controls include: re-contouring the land surfaces to enhance drainage, small scale facing/capping, and system for lining ditches and channels to carry water off the site to minimize infiltration.
			158	Quick setting admixture of cement type		
			155, 597	Polyurethane		
			239	Asphalt		
			91, 487, 25	Other Fiber reinforced composite material, Hydrophobic nano-fiber, Nylon sheet		
	other		107 ,509	Proposal for area of covering, advice for covering		
			196, 602	Roof over tanks		
			598	Volume reduction of felling		
			675	Polymer absorbent, Spraying from air		
(3) Collecting radioactive strontium in the soil	absorbents		724	Absorbent sheet-type	In regards to trap and collect the radioactive Sr in the soil, there are proposals relating to absorbents and collecting methods. Concerning the absorbents for Sr, many proposals are related to zeolite and some of to microbes. Concerning trapping and collecting methods, there are proposals to create permeable reactive barriers by absorbents (reactive materials) filling in excavated trenches or to form the barrier by injecting absorbents in the soil. Zeolite and apatite are mainly adopted as absorbents which have many results in foreign countries.	Improving the ground to capture strontium by mixing absorbents into the soil is a possibility. In implementing this, however, the effectiveness of proposed technologies should be judged in a comprehensive manner. In the trench or soil where groundwater flow is slow, absorbent or co-precipitation will be applicable. For this case, it is necessary to evaluate the applicability and waste treatment. Permeable reactive barrier (treatment system) at a suitable location has a high possibility to immobilize radioactive strontium. For the proposed immobilization method, further study is needed in terms of effectiveness, feasibility, wastes, etc. Permeable reactive barriers have some relevant industrial experience using apatite, zeolites, etc. overseas. One of the most appropriate locations for such a system is on the seaward side of reactor building. However, the ground water in this area is scheduled to be isolated in the next few years with the landside and seaside barriers. As for the absorbent for immobilizing radioactive strontium, there is apatite which has a high applicability aside from microbe and plant.
			250	Absorbent		
			343	Zeolite		
			430	Absorbent sheet-type (zeolite)		
			637	Artificial Zeolite		
			75, 79	Microbe(ureolysis) and mineral		
	collecting method	permeable reactive barrier	180, 229, 281, 318, 404, 509, 653, 746	Apatite, Zeolite, Other		
		injection method	639, 751, 386, 707	Micro scale zero-valent iron, Micro-apatite, Development of easy collection type absorbents		
		other	121, 484	Jerry type, Freeze-thaw		
			343, 512	Electro-kinetics		
			189	Proposal of R&D		
(4) Curbing groundwater at the mountain side	in the vicinity of boundary		107, 561	Effectiveness of drainage at the boundary	As different concepts from impermeable walls, there were many proposals that groundwater is collected near the mountainside boundary and drain to the sea directly. Conventional methods such as trench, tunnel and well are combined in practical. There is a proposal from the Japanese Society of Limnology that trench should be installed at the mountainside which will not be affected by the contamination from the reactor buildings.	The idea of "passive bypass" in the mountain area is innovative, and has a significant potential to be transformative in terms of water balance. Physical installation of any system will be in an up-gradient area that is less contaminated with less interferences. It would simplify logistics and reduce costs. We recommend starting up the existing bypass wells and operating the active bypass system. However, the bypass wells are down-gradient of water storage tank area. In case leakage occurs from tanks, the active bypass wells would become contaminated. We should provide additional countermeasure such as bypass near the mountain.
			109, 184, 195, 393, 423, 611	Trench		
			2, 230, 240, 475, 577	Tunnel		
			33, 728	Well		
	at the mountain side		31, 617, 165, 150	Well or trench		
(5) Other	advice & introduction	advice	739, 740	CMD Conceptual Model Development	For others, we have received many suggestions and introductions of related technologies. Implementation timing of countermeasures should be same with frozen-soil walls. There is a proposal on the utilization of CMD (conceptual model development) from overseas. CMD is a tool to decide strategies which establishes a model in order to specify the relationship among the key parameters (geology, groundwater, contamination, environment, etc.). Models will help to communicate with the stakeholders at the meeting for local communities.	In evaluating the proposed technologies, it is important to give higher priority to the methods to be able to launched immediately, even if they are not the best. CMD (Conceptual Model development) is utilized overseas. It will be useful in any phase of long-lasting decontamination work.
			542	Smooth and quick method		
			748	Stakeholder communications		
			760	Environment within the building		
			391	Safety measurement for worker		
		introduction	112, 736	Consultant		
			732	Evidence support logic and Bowtie tools		

＊ This is provisional translation