Eskom	INGXELO	IYUNITHI ESEBENZISA INYUKLIYA

Umxholo: **Uxwebhu Lukawonke-wonke Lokwandisa Ixesha Lokusebenzisa Isitishi Sokuphehla Umbane Ngenyukliya SaseKoeberg**

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ISISHWANKATHELO

UEskom ungumnini weLayisenisi Yesitishi Senyukliya (NIL-01 uhlelo 21) [1] yesikhululo Sokuphehla Umbane ngenyukliya saseKoeberg (iKoeberg), eneeyunithi ezimbini zeriektha (Reactor) ezisebenzisa amanzi axinzelelweyo ukuphehla iiyunithi eziyi-930 MWe. Esi sitishi saqalisa ukusebenza ngeenjongo zorhwebo ngo-1984, kwaye uphononongo lokuqala lokhuseleko lwaqikelela ukuba siza kusebenza iminyaka eyi-40. IYunithi 1 ukufikelela kwiminyaka engama-40 yokusebenza kwezorhwebo Julayi 2024 kwaye ukususela ngoko yandise ukusebenza kwayo kwezorhwebo ngelixa iYunithi 2 ziza kufikelela kwiminyaka eyi-40 ngo--2025 ngokulandelelana kwazo. IKoeberg oko yavelisa umbane ngokukhuselekiyo nangokuthembekileyo, isebenzisa amandla enyukliya acocekileyo, ngaphezu kweminyaka eyi-40. IKoeberg ihambisana nemigaqo siseko eyenzelwe onke amashishini asebenzisa inyukliya, isebenzisa iinkqubo zolawulo ezivunywe kumazwe ngamazwe naselizweni lonke, kwaye iqesha abasebenzi abanemfundo efanelekileyo, baqeqeshwa ngokusemthethweni ukuze bagunyaziswe ukwenza imisebenzi yabo.

I-Koeberg Unit 1 ifumene ilayisensi yayo ye-Long-Term Operation (LTO) kwi-NNR evumela ukuba isebenze eminye iminyaka engama-20 kude kube ngumhla wama-21 kuJulayi 2044. Iphepha-mvume lokufakelwa kombane waseKoeberg, i-NIL-01 liye lahlengahlengiswa laba yiVariation 21 ukubonisa umhla omtsha wokuphela kwelayisensi yeYunithi 1. Ibhodi ye-NNR ihlehlise isigqibo malunga nelayisensi ye-LTO yeCandelo 2 ukuya kuNovemba ka-2025. Esi sicelo esifakwe kwiNNR sokwandisa ixesha lokusebenzisa iKoeberg ngaphaya kwexesha elibekwe kwi-NIL-01 sibizwa ngokuba sisicelo sokwandisa ixesha lokusebenza kuphehlwa umbane eKoeberg (long-term operation [LTO]). Isicelo selayisenisi siyahambisana neMigaqo Yolawulo Yokwandisa Ixesha Lokusebenza [2] kwaye sisekelwe kumqulu oneenkcukacha zokhuseleko (safety case) lukaEskom, ebonisa ukuba iKoeberg inokusetyenziswa ngokukhuselekileyo ubuncinane iminyaka eyi-60 ngeenjongo zorhwebo.

Olu xwebhu lwenkcazelo kawonke-wonke (public information document [PID]) injongo yalo kukunika uwonke-wonke inkcazelo eyaneleyo ngemingcipheko yeradiyeyishini (radiation) kukhuseleko, kwimpilo, nakokusingqongileyo ngenxa yokwandiswa kwexesha lokusebenza kweKoeberg ngeminye iminyaka eyi-20. Oku kuza kwenza ukuba abantu bakwazi ukuthatha inxaxheba evakalayo kwinkqubo yokuthethana nabantu ngendlela yemigaqo ebekiweyo.

Isigqibo sikaEskom sokufuna iLTO sihambisana nemigaqo yesiqhelo yoshishino lwenyukliya. Sithethanje kukho iiriyektha zenyukliya eziyi-190 ehlabathini jikelele esezisebenze iminyaka eyi-40 nangaphezulu [3]. EUnited States of America (USA), iKhomishini Elawula Inyukliya igunyazise izicelo zokongezwa kweminyaka yokusebenza ukusukela kweeyunithi zeriyektha eziyi-94 zenyukliya ukusuka kwiminyaka eyi-40 ukuya kwiminyaka eyi-60, Kwaye ezinye iiyunithi ezintandathu zeeriyektha zenyukliya zaseUSA zigunyaziswe ukuba zisebenze iminyaka eyi-

80 [4]. Le nto ingqina ukuba iLTO iyanceda kwezoqoqosho kwaye ayizi namngcipheko ongafanelekanga xa imvume ifunyenwe emva kokulandela iinkqubo ezingqongqo zemimiselo.

Umqulu oneenkcukacha zokhuseleko lweLTO uza nezibakala nobungqina obuqulunqiweyo babhalwa phantsi obubonisa ukuba akukho mngcipheko weradiyeyishini ongeyomfuneko kukhuseleko, impilo, okanye kokusingqongileyo. Ingcaciso ngomqulu oneenkcukacha zokhuseleko isekelwe kwiintlolo ngeentlolo zokhuseleko ezenziweyo ukuze kuxhaswe iLTO. Uhlolo lokhuseleko

lwamaxesha athile (periodic safety review [PSR]) luhlolo lokhuseleko olucokisayo lweenkalo zokhuseleko eziyi-14 (ezibandakanya izinto ezahlukeneyo ezifunekayo kukhuseleko) ukuze kwenziwe isigqibo sokuba iKoeberg ihambisana kangakanani nemigaqo efunekayo yokhuseleko esetyenziswa kumazwe ngamazwe, kweli, nakwimimiselo kwaye kubonwe izinto ezinokuphuculwa kukhuseleko. Malunga ne-1 150 yemigaqo efunekayo kukhuseleko iye yahlolwa. Iziphumo zePSR ziqinisekisile ukuba ukuqhubeka nokusebenzisa iKoeberg ngendlela ekhuselekileyo ziyakuxhasa, kuquka neLTO.

Iinkqubo ezisebenzayo zokulawula ukuguga koomatshini zingazithintela iziphumo ezibi zingachaphazeli ukuthembeka koomatshini besi sitishi ebudeni bexesha leLTO. UMzantsi Afrika umeme iArhente Yamandla eAthom Yamazwe Ngamazwe (International Atomic Energy Agency [IAEA]) ukuba iphonononge iinkalo zokhuseleko xa iKoeberg isetyenziswa ixesha elongezelelweyo (safety aspects of long-term operation [SALTO]). Olu hlolo belujoliswe ekuncedeni iKoeberg ilandele indlela ekhuselekileyo nesebenzayo kwiLTO ilandela inkqubo equlunqwe kakuhle kwaye kukho negalelo elivela kwiingcali zamazwe ngamazwe. Injongo ebalulekileyo yeSALTO yayikukuhlola iinkqubo zokulawula ukuguga koomatshininkqubo zaseKoeberg ukuba ziyasebenza kwaye ziphelele na, ukuze ziphuculwe apho zisilela khona ngenjongo yokuqinisekisa ukuba oomatshini abagugayo balawulwa ngendlela efanelekileyo.

NgoMashi 2022 i-IAEA yaqhuba iphulo leSALTO lokukhangela ukuba iKoeberg iyilungele kangakanani iLTO. Kwabhaqeka iingxaki eziyi-14 ezazingabhekiselelanga kwimiba yokhuseleko, koko yayingamacebiso nezindululo zokuphucula amalungiselelo eLTO. Inani neentlobo zemiba zazifana nezo zabhaqeka ngexesha lephulo leSALTO kwamanye amaziko enyukliya akwazileyo ukuzandisela ubomi bamaziko lawo. Zonke iimpapasho ezilishumi elinesine zivaliwe ngempumelelo. Amanyathelo okulungisa asetyenzisiweyo ukujongana neengcebiso ze-IAEA ayesengqiqweni, ebekwe kakuhle, ehambelana neyona ndlela isebenzayo kushishino, kwaye akhokelela kuphuculo olunokulinganiswa. Ukuphuculwa nokulawula ukuguga, iimvavanyo, neenkqubo zokubeka esweni, oomatshini, izakhiwo, neekhomponenti (systems, structures, and components [SSC]) kuza kuqhubeka ngaphambi kweLTO nasebudeni ngalo lonke ixesha leLTO ukuze kuqinisekiswe ukuba kusetyenzwa ngendlela ekhuselekileyo, nethembekileyo.

Ilayisenisi Yesitishi Senyukliya eyiNIL-01 ibeka imiqathango yelayisenisi eliqela ekufuneka iKoeberg iyithobele. Iquka imiqathango yokukhuselwa kwabantu kwiradiyeyishini, ukukhuselwa kokusingqongileyo, ukulawulwa kwenkcitho eneradiyeyishini, ukulungiswa nokuhlolwa kwezixhobo zesi sitishi, neminye emininzi. Kulindelwe ukuba le miqathango yelayisenisi ihlale isebenza ebudeni beLTO kwaye iKoeberg iqhubeke nokuthobela imiqathango yelayisenisi. I-NNR yiyo ejonga umsebenzi owenziwa eKoeberg ngokubeka esweni ukuthotyelwa kwemiqathango yelayisenisi nangamanyathelo okunyanzelisa ukuba imiqathango yelayisenisi iyathotyelwa. Ulawulo olungqongqo olunikelwa yiNNR luye lwafaka isandla ekuqhubekeni kusetyenzwa ngendlela ekhuselekileyo eKoeberg kwaye luza kuqhubeka lusenjenjalo ebudeni beLTO.

I-NNR ibeke izinto eziphambili ezijongwayo kukhuseleko [5] phakathi kwazo kukho izinto ezijongwayo kumngcipheko nemida yedowusi (dose limits) ukuze kukhuselwe abasebenzi nowonke-wonke kuzo zonke iimeko zokusebenza neziganeko ezinxulumene nezitishi zenyukliya eziphehla umbane. Izinto eziphambili ezijongwayo kukhuseleko zinezinto ezifunekayo kwiimeko ezingenakuphepheka nakwiimeko ezinokwenzeka, kwaye injongo yezinto eziphambili ezijongwayo kukhuseleko kukuqinisekisa ukuba umsebenzi owenziwa eKoeberg awudali imingcipheko

yenyukliya engeyomfuneko kwaye/okanye imingcipheko yokukhuseleka kwiradiyeyishini kubasebenzi okanye kuluntu. Izinto eziphambili ezijongwayo kukhuseleko zeNNR zihambelana nezona ndlela zilungileyo zokwenza izinto kumazwe ngamazwe.

I-PSR iye yaqinisekisa ukuba iKoeberg izifikelele izinto eziphambili ezijongwayo kukhuseleko nokuba umngcipheko kuluntu ubungaphantsi kwe-3% yezinto eziphambili ezijongwayo yiNNR kukhuseleko, noxa umngcipheko kubasebenzi ubungaphantsi kwe-20%. Le mingcipheko ingaphantsi kwenqanaba elithathwa njengelinyamezelekayo [6] kwaye ingaphantsi kakhulu kunomngcipheko, ngokomzekelo, wokubulawa yingozi yemoto eMzantsi Afrika.

Idowusi yeradiyeyishini enokuchaphazela abasebenzi noluntu ngokubanzi ngenxa yokusebenza kweKoeberg ingaphantsi kakhulu kunemida ebekwe ngumthetho. Umda wedowusi yoqobo yonyaka kuluntu ngenxa yawo wonke umsebenzi ogunyazisiweyo wenyukliya eMzantsi Afrika yi-1 mSv ngonyaka, noxa isisikelo sedowusi esisebenza eKoeberg kumntu omeleyo iyi-0,25 mSv ngonyaka [7]. I-PSR yaqinisekisa ukuba i-Koeberg iyithobele imida yedowusi kwaye imilinganiselo yedowusi yonyaka kuluntu ibingaphantsi kwe-1% yomda wedowusi obekwe ngumthetho.

Imida yedowusi yoqobo yonyaka kubasebenzi beradiyeyishini yimilinganiselo ephakathi kwe-20 mSv ngonyaka ngokwe milinganiselo ephakhathi kweminyaka emihlanu elandelanayo kwaye kungagqithwa kwidowusi eyi-50 mSv nangawuphi na unyaka omnye [7]. Iziphumo zePSR zaqinisekisa ukuba iKoeberg iyawuthobela umda wemilinganiselo ephakathi yedowusi yoqobo yonyaka nesisikelo sedowusi ekungamele kudlulwe kuso kubasebenzi esibekwe ngumthetho.

PSR iqinisekise nokuba ukuchaphazeleka okungakho kubasebenzi nakuwonke-wonke kwiradiyeyishini kusoloko kugcinwa kuphantsi kangangoko kunokufikeleleka (as low as reasonably achievable [ALARA]) kwaye kungaphantsi kwemida ebekwe yimiyalelo kusetyenziswa imigaqo neenkqubo zokukhusela kwiradiyeyishini ezisebenzayo.

Ifuthe lomsebenzi owenziwa ngoku eKoeberg kokusingqongileyo lincinci kwaye alidlulanga kwimida ebekwa yimiyalelo. Amanzi neerhasi ezimdaka ezikhutshwayo ebudeni bomsebenzi oqhelekileyo zikhutshwa phantsi kweemeko ezilawulwayo kwaye kufuneka zilandele umlinganiselo wonyaka ogunyazisiweyo wokuzilahla (annual authorised discharge quantity [AADQ]), ehambelana nomda wedowusi yoqobo ekungenakudlulwa kuyo ebekwe ngumthetho. Idowusi kawonke-wonke elindelweyo yabalwa kucingwa ngokukhula kokusingqongileyo kwiminyaka eyi-60 yeLTO kusetyenziswa uqikelelo oluphantsi. I-PSR iye yaqinisekisa ukuba idowusi kawonke-wonke yamanzi neerhasi ezikhutshwayo ayiyi kugqitha kwisisikelo sedowusi esiyi-0,25 mSv. Singaphantsi kakhulu kwimilanginiselo ephakathi yamanqanaba eradiyeyishini ekhoyo kokusingqongileyo emalunga ne-2,4 mSv ngonyaka [9]. Imilinganiselo ephakathi yedowusi yonyaka kumntu ngamnye ohlala kufutshane neKoeberg ungaphantsi ngokuphindwe kayi-100 kowedowusi efunyanwa kwiradiyeyishini yendalo efumaneka kokusingqongileyo. Ngoko, amathuba okuba zichaphazele impilo ngenxa yomsebenzi owenziwa eKoeberg aphantsi kakhulu.

Ukuxhaswa ngezizathu zobugcisa kweLTO kwaqinisekiswa ziziphumo zePSR. Ezinye zezigqibo ekwafikelelwa kuzo zezi zilandelayo:

Olu yilo (design) lukhoyo lweKoeberg lusemgangathweni xa luhlolwa luthelekiswa nemeko yelayisenisi, nemigangatho yelizwe, kwaneyamazwe ngamazwe.

Iinkqubo ezinxulumene nokugcinakala kakuhle kweziko ziqhuba kakuhle, neenkqubo zinonotshelwe.

Eyona meko zikuyo iiSSC ezibaluleke kukhuseleko ibangela ukuba ithenjwe into yokuba kungakwazeka ukusebenza ngokukhuselekileyo ebudeni bobomi beLTO.

Iinkqubo zokulawula ukuguga, iinkqubo emazilandelwe, neendlela zolawulo ubukhulu becala zihambisana nemigangatho yamazwe ngamazwe, kwaye nezindululo malunga nokhuseleko olungcono ziya kuqinisekisa ukuba kusetyenzwa ngendlela ekhuselekileyo ebudeni bayo iLTO.

Indlela oluqhuba ngayo lulonke nje ukhuseleko lwenyukliya eKoeberg ikumgangatho owamkelekileyo. Zonke izinto ezingenziwa ngendlela eqhelekileyo ezibonwe ebudeni bePSR zinamanyathelo achaziweyo okuziphucula, kwaye amaxesha okuthathwa kwalo manyathelo agqalwa njengafanelekileyo kwaye ahambelana nefuthe lawo lokhuseleko.

Emva kwengozi yaseFukushima eJapan ngo-2011 [10], iKoeberg yenza uvavanyo lokhuseleko ukuze ilungise izinto ezafundwa kwesi siganeko, esasinamathuba aphantsi kakhulu ukuba senzeke. Uhlolo lokhuseleko lwalujolise kwiziganeko eziqatha zangaphandle (ezifana neenyikima kunye neetsunami) ezinokuba nefuthe elibi ekusebenzeni ngendlela ekhuselekileyo, nasekulungeleni imeko yongxamiseko nentsabelo. Njengesiphumo sohlolo lokhuseleko, iKoeberg ithathe amanyathelo aliqela okuphucula ukukwazi kwayo ukusabela kwiziganeko ezinjalo (anjengombane ongakumbi, eminye imithombo yamanzi okupholisa, nezixhobo ezihambayo zokususa inkcitho ekhutshwayo ebangelwe yinyikima). Ingxelo entsha yokhuseleko lwesiza kusetyenziswa iindlela zakutshanje namava emigangatho yokusebenza. Ngaphezu koko, ezicwangcisiweyo kwaye ziza kuzakuqhubeka kwenziwe uphuculo olungakumbi, luphucula nangakumbi ukhuseleko eKoeberg ebudeni beLTO.

Ukuba nabasebenzi abaneleyo abakwaziyo ukwenza umsebenzi kubalulekile ukuze kuxhaswe iLTO. Izinto ezifunekayo ukuze abasebenzi bakwazi ukwenza umsebenzi nokuze kulawulwe ulwazi zichazwe kumaxwebhu emiyalelo eNNR ([11] no-[12]). IKoeberg ineenkqubo zolawulo eziyimfuneko, iinkqubo zokuqeshwa kwabasebenzi, kunye nezakhiwo zokuqeqesha ukuze kuqinisekiswe ukuba bakho abasebenzi abakwazi ukusebenza nabaxhasa iLTO. Iikontraktha (contractors) ezinamava kakhulu ziye zafunyanwa ukuze zixhase ukwanda komsebenzi kwixesha elifutshane ukuya kweliphakathi ngenxa yeLTO noxa kusetyenziswa amaphulo okuqesha ukuze kuvalwe ngokusisigxina izithuba zomsebenzi ebezivulekile xa kuyimfuneko. Inkqubo yokulawulwa kolwazi yaseKoeberg yaphuculwa nangakumbi kwaye iyandiswa ukuze ihambisane neendlela ekwenziwa ngazo kumazwe ngamazwe. Iinkqubo zokuqesha, zokuqeqesha, nezokuphuhlisa abasebenzi ezingqongqo zaseKoeberg zihambelana neendlela ekwenziwa ngazo kumazwe ngamazwe.

UEskom uzibophelele ekwenzeni imali efunekayo ifumaneke ukuze kukwazeke ukusebenza ngendlela ekhuselekileyo nenokuthenjwa kwiLTO. Ngokungqinelana noMthetho Wokulawulwa Kwemali KaRhulumente neminye imithetho, iBhodi YakwaEskom iqwalasela ize igqibe ngendlela eza kufunyanwa ngayo imali yokusebenza nguEskom, ukujonga imali efunekayo kwaEskom, ngamaxesha athile. UEskom uphinde wenza amalungiselelo okuqinisekisa ukuba kukho imali eyaneleyo, njengoko kubonisiwe kwingxelo yakhe yonyaka yemali, yokuvala iKoeberg, kuquka ukulungisa umhlaba obandakanyekayo nokulawula amafutha asetyenzisiweyo nenkcitho eneradiyeyishini.

Uphononongo lwenkqubo yokhuseleko lwenyukliya (nuclear safety culture [NSC]) lwenziwa qho emva kweminyaka emithathu, kusetyenziswa imilinganiselo yeZiko Lemisebenzi Yombane Wenyukliya (Institute of Nuclear Power Operations [INPO]) yeNSC esempilweni [13]. Imilinganiselo eyi-10 yeNSC esempilweni (ngamnye oneempawu nezenzo zawo) iqwalaselwa njengomgangatho wezitishi zenyukliya. Ngo-2025, i-NNR yenze uhlolo lwenkcubeko ye-NSC kwaye ayifumananga kukungathobeli. Ngokusebenzisa uphando kugqitywe ekubeni noxa ekho amathuba okuphucula, iNSC kwiYunithi Esebenza Ngenyukliya ikhuseleke ngendlela eyamkelekileyo ukuba iqhubeke isetyenziswa kwiLTO.

I-NIL-01 inemigaqo ephathelelene nezothutho, ukulahla, nokugcina inkcitho ekhutshwayo eneradiyeyishini. Inkcitho ekhutshwayo eneradiyeyishini ekwinqanaba eliphantsi neliphakathi-yexeshana (low- and intermediate-level waste – short-lived [LILW-SL]) kunye nenkcitho yenqanaba eliphezulu (high level waste [HLW]) iyaveliswa eKoeberg ngenxa yomsebenzi, ukulungisa, notshintsho olwenziwa khona. Sithethanje, amafutha asetyenzisiweyo (HLW) agcinwa ngokukhuselekileyo esizeni kumachibi amafutha asetyenzisiweyo nakwii bhokisi ezomileyo (dry-storage casks). Amafutha asetyenzisiweyo anokudluliselwa kwisakhiwo sexeshana sokugcina esiphakathi (centralised interim storage facility [CISF]), esakhiwa liZiko Lelizwe Lokulahlwa Kwenkcitho Eneradiyeyishini [National Radioactive Waste Disposal Institute [NRWDI]) nesiphantsi kweenkqubo zogunyaziso ezifunekayo [14]. Lo gama iCISF ingekasebenzi, amafutha asetyenzisiweyo kunye nezakhiwo zokugcina iifatyi ezomileyo kumaziko ziza kuqhubeka zisetyenziselwa ukugcina amafutha asetyenzisiweyo ebudeni bexesha leLTO. IKoeberg isephulweni lokwengeza inani leefatyi zokugcina ezomileyo {elikwabizwa ngokuba *yiTransient Interim Storage Facility* (TISF) ukuqinisekisa ukuba zikho ngokwaneleyo iindawo zokugcina. Ilayisensi ye-TISF yokwakha igunyazwe yi-NNR.

I-LILW-SL ingcitywa okanye ifakwa kwimigqomo ehambisana nezinto ezijongwayo kwinkcitho ekhutshwayo eyamkelekayo eVaalputs kwaye zigunyaziswa yiNNR. Izinto ezijongwayo ukuze inkcitho ekhutshwayo yamkeleke zichaza iimpawu zeradiyeyishini, zoomatshini, zeekhemikhali, nezebhayoloji zepakeji yenkcitho ukuze kuqinisekiswe ukuba inkcitho ekhutshwayo igqunywa ngendlela eyiyo kwaye ingagcinwa ngendlela ekhuselekileyo. UEskom ucele ngokusemthethweni iNRWDI ukuba ilungiselele umthamo ongakumbi wokugcina iLILW-SL ngenxa yeLTO. I-NRWDI ivumile ukuba umthamo oseleyo wokugcina usenakho ukugcina intsalela eyenzeke ngexesha leLTO.

Iindlela zokugcina intsalela ekhutshwayo yaseKoeberg zeLILW-SL nezeHLW zihambelana neendlela ezisetyenziswa kumazwe ngamazwe kwaye zinomngcipheko ophantsi kakhulu kukhuseleko, kwimpilo, nakokusingqongileyo.

Lonke uvavanyo lokhuseleko nemisebenzi efunekayo phambi kwe-LTO yeYunithi 2 igqityiwe. Ukuphuculwa kokhuseleko kunye namanyathelo afunekayo ukuba aphunyezwe ngexesha le-LTO achongiwe, kwaye u-Eskom uyaqhubeka nokuphunyezwa kwawo..

Ekugqibeleni, kuboniswe ukuba akukho mngcipheko uxhalisayo kukhuseleko, kwimpilo, okanye kokusingqongileyo xa kuqhutyekwa kusetyenziswa iKoeberg Yunithi 2 eminye iminyaka eyi-20. Isicelo sokusebenzisa iKoeberg Yunithi 2 ukuya kutsho kwiminyaka eyi-60 siya kubonwa yiNNR.

IZIQULATHO

IMIFANEKISO

IITHEYIBHULI

1. INJONGO

Injongo yolu xwebhu lwenkcazelo kawonke-wonke (PID) kukunika uluntu inkcazelo eyaneleyo ngesicelo sikaEskom asifake kuMlawuli Wenyukliya Wesizwe (NNR) sokuba kutshintshwe iLayisenisi Yesitishi Senyukliya (NIL-01) ukuze kuqhutyekwe kusetyenziswa iSitishi Sokuphehla Umbane Wenyukliya SaseKoeberg nasemva kwe-9 Novemba 2025, kongezwe eminye iminyaka eyi-20, kuyiwe kwi- 9 kaNovemba 2045 yeminyaka engama-20, egunyazisa u-Eskom ukuba asebenzise iYunithi 1 yeSikhululo Samandla Enyukliya saseKoeberg kude kube ngoJulayi 21, 2044. Esi sicelo sibizwa ngokuba sisicelo sokwandisa ixesha lokusebenza kuphehlwa umbane eKoeberg (long-term operation [LTO]) kwaye safakwa kwiNNR ngokuhambisana nemithetho yelizwe enxibelelene nemiqathango esekwe yiNNR. Isigunyaziso sokuba iKoeberg Yunithi 2 isebenza eminye iminyaka eyi-20 siza kugqitywa yiNNR emva kokulandelwa kwenkqubo efanelekileyo, naxa izanelisile ukuba ziyavakala izizathu zokuqhubeka isetyenziswa ngendlela ekhuselekileyo.

2. UMBANDELA (UBUBANZI BOLU XWEBHU)

I-PID iqulethe inkcazelo malunga nemingcipheko yeradiyeyishini kukhuseleko, kwimpilo, nakokusingqongileyo enxulumene nesicelo se-LTO, umthetho welizwe, kwakunye nemiqathango enxulumeneyo esekwe yiNNR.

3. ISAKHIWO NOMONGO

I-PID iqala ngengcombolo yemvelaphi yeLTO (Isahluko 5), kulandele iziseko zomthetho kunye nesakhelo semiyalelo yokulawula iLTO (Isahluko 6). Icandelo 6.1 lenza amagqabantshintshi ngengcaciso yomqulu oneenkcukatha zokhuseleko lweKoeberg (safety case) kwaye libhekisela kumacandelo anxibeleleneyo akwiPID anento yokwenza nokhuseleko. I-PID emva koku inikezela ngenkcazelo yomfaki-sicelo nengcaciso yesiza kwiSahluko 7 neSahluko 8, ngokulandelelana. Emva koku kulandela ingcaciso yomsebenzi owenziwa eKoeberg (kwiSahluko 9) ukuze umfundi abe nofifi ngokwenzeka kwesi sitishi sombane.

Isahluko 10 sithetha ngemingcipheko yokhuseleko, impilo, nokusingqongileyo, kulandele izizathu zobugcisa ezithethelela iLTO kwakunye namalungiselelo okulawula inkampani jikelele, kwiSahluko 11 nakwiSahluko 12, ngokulandelelana. Isahluko 11 siquka inkcazelo ngeziphumo zohlolo lokhuseleko olwenziwe eKoeberg, ikakhulu ezinxulumene neziphumo zokuguga kwesi sitishi kunye neenkqubo ezijongene neenkqubo ezibalulekileyo ezidibene nokhuseleko ezinjengokukhuselwa kwiradiyeyishini kunye nezicwangciso ezikhoyo xa kungakho iimeko zikaxakeka zengozi yenyukliye (emergency planning). Oku kuquka indima yeInternational Atomic Energy Agency (IAEA)

yokuphononongwa ziingcali zenyukliya zamazwe ngamazwe, imiba yokhuseleko yenkqubo yokusebenzisa ixesha elongezelelweyo (SALTO), Isishwankathelo seziphumo zophando lwe-IAEA lwe-SALTO iziphumo zothumo, kunye nokuhlolwa kokhuseleko lweKoeberg okwaziwa ngokuba luhlolo lokhuseleko lwamaxesha athile (PSR). Zonke ezi ntlobo zohlolo lokhuseleko zenziwa ukuze kukwazeke ukuthatha isigqibo sokuba iLTO ingakwazi ukuxhaswa ngendlela ekhuselekileyo na.

Isahluko 13 neSahluko 14 zithetha ngokulawulwa kwemvuthuluka yeradiyeyishini eyenzekayo. Isahluko 15 sisishwankathelo semisebenzi yeLTO iLTO. Umqukumbelo kunye noluhlu lweencwadi ezisetyenzisiweyo ukulungisa olu xwebhu oluneenkcukacha zokhuseleko (iireferensi) nazo zinikezelwe.

4. IINGCACISO, IZIFINYEZO KUNYE NEZISHUNQULELO, NEEMPAWU ZEEKHOMPAWUNDI

4.1 Iingcaciso

Ibinzana	Ingcaciso
Idowusi engenileyo	Ubungakanani bamandla afakwe yiradiyeyishini entweni, alinganiswa nge-grey (Gy), i-milligray (mGy), okanye i-microgray (µGy).
Iimveliso ze-activation	Ukuveliswa kwee-radionuclides okungacetywanga kwisipholisi seriyektha, kwiimathiriyali zesakhiwo, neemathiriyali ezikhuselayo okubangelwa kukuchanabeka (exposure) kwii-neutrons.
I-bioaccumulation	Ukuqokelelana kwee-radionuclides kwisidalwa esitya ukutya okanye esisela amanzi anemathiriyali eneradiyeyishini.
Igridi	Iintambo ezihambisa umbane ukusuka kwisitishi esiwuphehlayo ukuya kubasebenzisi bombane.
Isithintelo	Isilinganiso sedowusi enye (isithintelo yedowusi) elindelekileyo nenxulumene nomthombo okanye somngcipheko omnye (isithintelo yomngcipheko) esisetyenziswa kwiimeko ezicetyiweyo umntu aza kuchanabeka ngazo ukuze kuphuculwe ukukhuselwa komthombo weradiyeyishini, kwaye iba ngumda ekuchazeni ukhetho olukhoyo lokuphuculwa. i) Ekuchanabekeni emsebenzini, sisithintelo kwidowusi enye kubasebenzi efunyenwe yaza yasetyenziswa ngababhalisi nangabanini layisenisi ukuze basete umkhamo wokhetho lokuphuculwa kokhuseleko kumthombo weradiyeyishini. ii) Ekuchanabekeni kukawonke-wonke, isithintelo sedowusi sisilinganiso esinxibelelene nomthombo weradiyeyishini esifunyenwe okanye esigunyaziswe yibhodi elawulayo karhulumente, kucingwa ngeedowusi ezivela kumsebenzi ocetyiweyo wayo yonke imithombo ephantsi kolawulo. iii) Isithintelo sedowusi yomthombo weradiyeyishini ngamnye injongo yaso, phakathi kwezinye izinto, kukuqiniseka ukuba zizonke iidowusi zomsebenzi ocetyiweyo wayo yonke imithombo ephantsi kolawulo zihlala zingaphantsi kwedowusi esikelweyo. iv) Ekuchanabekeni kwezamayeza, isithintelo yedowusi sisiliganiso esinxibelelene nomthombo weradiyeyishini esisetyenziswa ukukhusela abongi nabathuthuzeli bezigulane ezinyangwa ngeenkqubo ezisebenzisa iradiyeyishini, nokukhusela amatshantliziyo xa echanabeke kwinkqubo yophando lwebhayoloji nonyango.

Ibinzana	Ingcaciso
	v) Isithintelo somngcipheko sisilinganiso esinxibelelene nomthombo esinikela ngomgangatho osisiseko wokhuseleko kubantu abangabona basemngciphekweni kumthombo weradiyeyishini. Lo mngcipheko unganamathuba okwenzeka xa kunokuhla isiganeko esingacetywanga esidala idowusi namathuba okuba kubekho umonakalo ngenxa yalo dowusi. Izithintelo zomngcipheko zihambisana nezithintelo zedowusi, kodwa zisebenza ekuchanabekeni okungenzeka.
Imiphumo engakho	Umonzakalo enyameni nakumalungu ngenxa yokufa kweeseli. Uphawulwa ngedowusi esikelweyo nangokunyuka kokuqatsela kwentsabelo xa idowusi inyuswa ngakumbi.
Uhlalutyo lokhuseleko kwimiphumo engakho	Uhlalutyo lokhuseleko kwimiphumo engakho lujoliswa ekuqinisekiseni ukuba imisebenzi yokhuseleko kunye neenkqubo, izakhiwo, neekhomponenti ezifunekayo, xa zidibene nezenzo zombhexeshi (apho kufanelekileyo), ziyakwazi, kwaye zisebenza kakuhle, ekugcineni ukuphuma kweradiyeyishini kukumanqanaba amkelekileyo yaye kukumda owaneleyo wokhuseleko.
Idowusi	Sisilinganiso samandla afakwa yiradiyeyishini kulo nto ajoliswe kuyo.
Ireyithi yedowusi	Yidowusi yeradiyeyishini efakwayo (engenayo) ngeyunithi yexesha. Ilinganiswa nge-millisievert (mSv) ngeyure.
Idowusi yoqobo	Ukudityaniswa kweedowusi ezilinganayo kuwo onke amalungu, zilungelelaniswe ukuze kucingelwe ubuntununtunu belo lungu kwiradiyeyishini. Ibalwa kumzimba wonke, ichazwa ngee-sievert (Sv), ii-millisievert (mSv), okanye ii-microsievert (µSv).
Ukutyebisa	Nayiphi inkqubo yokunyusa umlinganiselo we-U-235 kumxube wee-Uranium Isotopes iye kumanqanaba angaphezulu kunalawo afumaneka kwindalo, ekubeni ngokwendalo i-U-238 iyila malunga ne-99,274% kwaye i-U-235 imalunga ne-0,720%. Zikho nezinye ii-isotope ezinjenge-U-234 ne-U-236, kodwa ziyinxalenye encinane nje umzekelo. i-U-234 yi-0,005% kuphela. Okuseleyo kuyilwa yi-U-232, i-U-233, ne-U-236.
Idowusi elinganayo	Yidowusi efunxwe lilungu lomzimba, elungelelanisiweyo ukuze kujongwe ukusebenza kolo hlobo lweradiyeyishini. Ibalwa kwilungu lomzimba ngalinye, ichazwa ngee-sievert (Sv) okanye ii-millisievert (mSv).
Uyilo	Uyilo
Isiqingatha sobomi, ngokwebhayoloji	Lixesha lesiqingatha see-radionuclide ezimele zikhutshwe emzimbeni.
Isiqingatha sobomi, emzimbeni	Lixesha elifunekayo ukuze inani elithile lee-nuclide ezithile ezineradiyeyishini ziphelelwe ngamandla zibe sisiqingatha senani lezo bezikho ekuqaleni.
Iradiyeyishini	Ukukhutshwa kwamandla njengamaza e-electromagnetic okanye njengamasuntswana ashukumayo e-subatomic, ngakumbi amasuntswana anamandla aphezulu abangela i-ionization.

Ibinzana	Ingcaciso
Amafutha aneradiyeyishini	Ngamafutha enyukliya aye achanatywa kwiradiyeyishini yeenyutroni kwiriyektha yenyukliya, kodwa angade afike kwinqanaba lokukhupha amandla ebiyilelwe lona (design burnup).
Ukulawulwa kolwazi	Indlela edityanisiweyo nesebenzisa inkqubo ethile yokuchonga, ukufumana, ukutshintsha, ukuphuhlisa, ukusasaza, ukusebenzisa, ukwabelana, nokulondoloza ulwazi oludibene nokuphunyezwa kweenjongo ezichaziweyo.
Ukusebenzisa ixesha elongezelelweyo	Ukusetyenziswa kwesitishi ukugqitha kwixesha ebesibekelwe lona ngaphambili, ngokomzekelo, ixesha elisekwe kwilayisenisi, uyilo lwesitishi (plant design), imilinganiselo, ilayisenisi kunye/okanye imiyalelo, okuxhaswa kukuhlolwa kokhuseleko, kucingwa ngeenkqubo neenkalo ezilinganisela ubomi boomatshini, izakhiwo, neekhomponenti (systems, structures, and components [SSC]).
Ingozi yenyukliya	Sisiganeko okanye uthotho lweziganeko ezikhokelela ekuphumeni okungacetywanga kwezinto ezineradiyeyishini okanye ukuchanabeka kwiradiyeyishini engabangela ukuba ugqithe kwi-1 mSv yedowusi kuluntu okanye i-50 mSv yedowusi kubasebenzi.
Uhlolo lokhuseleko lwamaxesha athile	Luhlolo lokhuseleko kwisakhiwo esikhoyo olwenziwa rhoqo kwixesha elimisiweyo ukuze kujongwane nemiphumo eyandayo yokuguga, utshintsho, amava okusebenza, uphuhliso lobugcisa, neenkalo zesiza. Injongo yalo kukuqinisekisa ukuba ukhuseleko luphezulu ngalo lonke ixesha lokusebenza kweso sakhiwo.
Idowusi eqikelelwayo	Idowusi ekulindelwe ukuba ifunyanwe ukuba amanyathelo acetyiweyo okukhusela awathathwanga.
Isilwanyana okanye isityalo sembekiselo [Reference animal or plant (RAP)]	Into ecingelwayo eneempawu zobomi zohlobo oluthile lwesilwanyana okanye isityalo (ngendlela echazwe ngokohlahlelo lwaso lwentsapho) eneempawu ezichaziweyo zokwakheka, zamalungu nembali yobomi. I-RAP ingasetyenziselwa iinjongo zokuchaza ukuchanabeka kwidowusi nemiphumo yedowusi, kolo hlobo lwento ephilayo.
Umntu omeleyo	Ngumntu, ekuza kusoloko kuqikelelwa ngaye, ufumana idowusi emela oyena mntu uchanabeke kakhulu kubemi. Lo mntu umeleyo ulingana, kwaye uthatha indawo, yemilinganiselo ephakhathi yabantu abakwiqela elikwimeko embi.
Umngcipheko	Kukuxhaphaka nemiphumo yesiganeko, echazwa ngokuthi “ngamawele amathathu omngcipheko” ephendula le mibuzo mithathu ilandelayo: A. Yintoni engonakala? B. Mangakanani amathuba okuba kwenzeke oko? C. Ziintoni iziphumo ukuba ingenzeka? Kwimeko yeradiyeyishini, ngamathuba okuba kubekho isiphumo esithile sempilo (njengomhlaza) esenzeka kumntu okanye kwiqela labantu ngenxa yokuchanabeka kwiradiyeyishini.

Ibinzana	Ingcaciso
Uhlolo lokhuseleko	Kwimeko ye-PSR, uhlolo lokhuseleko lwenziwa njengendlela yokuvavanya ukuthotyelwa kwemiqathango o efunekayo kukhuseleko kuzo zonke izakhiwo nemisebenzi yesitishi neyokugqiba ngamanyathelo amele athathwe ukuze kuqinisekiswe ngokhuseleko.
Amafutha asetyenzisiweyo	Amafutha enyukliya aye afakwa kwiriyektha yenyukliya ukuze akhuphe amandla okwenza umbane, ade afikelele kwinqanaba lokuba loo mafutha aphelelwe ngamandla awasasebenziseki ekuqhubeni ireaction yenyukliya. La mafutha ayakhutshwa kwindlwana yeriyektha aze agcinwe ngaphantsi kwamanzi kwiishelufu zokugcina amafutha kumadama amafutha asetyenzisiweyo.
Imiphumo ethelekelelwayo	Yimiphumo ebangelwa ngumonakalo kwiseli enye, njengomhlaza neziphene kwimfuza. Ukuxhaphaka kwesiganeko, hayi ubuqatha baso, yanda ngokunyuka kwedowusi. Ukwenzela ukhuseleko, sithatha ngokuba ayikho idowusi esisisikelo.

4.2 Izishunqulelo nezifinyezo

Isishunqulelo/ Isifinyezo	Ingcaciso
AADQ	Umthamo ogunyazisiweyo wokuphumayo ngonyaka (Annual authorised discharge quantity)
ALARA	Phantsi kangangoko kunokufikeleleka (As low as reasonably achievable)
ALARP	Phantsi kangangoko kunokwenzeka (As low as reasonably practical)
AMP	Inkqubo yokulawula ukuguga (ageing management programme)
DMRE	Isebe Lobuncwane Bezimbiwa Namandla (Department of Mineral Resources and Energy)
DSSR	Ingxelo ngokhuseleko kwiziko iDuynefontyn
EDF	I-Électricité de France
EPD	I-electronic personal dosimeter
EPRI	Iziko Eliphanda Ngamandla Ombane (Electric Power Research Institute)
UEskom	Eskom Holdings SOC Ltd
GSR	Izinto eziqhelekileyo ezifunekayo kukhuseleko (General safety requirements)
Gy	Gray
HLW	Inkcitho eneradiyeyishini ekhutshwayo ekwinqanaba eliphezulu (High level waste)

Isishunqulelo/ Isifinyezo	Ingcaciso
IAEA	Iarhente Yamazwe Ngamazwe Yamandla EAthomu (International Atomic Energy Agency)
I&C	Ukufakela izixhobo nolawulo loomatshini (Instrumentation and control)
ICCP	Ukhuseleko lombane wekathodiki (cathodic)
ICRP	Ikomishini Yamazwe Ngamazwe Yokukhusela Kwiradiyeyishini (International Commission on Radiological Protection)
ILRT	Uvavanyo lwamaqondo okuvuza
ILW	Inkcitho eneradiyeyishini ekhutshwayo ekwinqanaba eliphakathi (Intermediate level waste)
INPO	Iziko Lemisebenzi Yombane Wenyukliya (Institute of Nuclear Power Operations)
ISO	Umbutho Wamazwe Ngamazwe Wemilinganiselo (International Organisation for Standardisation)
LILW	Inkcitho eneradiyeyishini ekhutshwayo ekwinqanaba eliphantsi neliphakathi leradiyeyishini (Low and intermediate level waste)
LILW-SL	Inkcitho eneradiyeyishini ekhutshwayo ekwinqanaba eliphantsi neliphakathi leradiyeyishini yexeshana (Low and intermediate level waste short lived)
LLW	inkcitho eneradiyeyishini ekhutshwayo ekwinqanaba eliphantsi (Low level waste)
LPZ	Ummandla wokucebela inyathelo lokhuseleko lwexesha elide (Long term protective action planning zone)
LTO	Ukusebenzisa ixesha elongezelelweyo kunelo beliphunyeziwe ekuqaleni (Long-term operation)
mWe	Megawatt (iyunithi yombane)
MWth	Megawatt (iyunithi yamandla awenziweyo eboniswa ngobushushu)
Necsa	Inkampani Yamandla Enyukliya YaseMzantsi Afrika (South African Nuclear Energy Corporation)
NIL	Ilayisenisi yesitishi senyukliya (Nuclear installation licence)
NNR	Umlawuli Wenyukliya Welizwe (National Nuclear Regulator)
NNRA	Umthetho Womlawuli Wenyukliya Welizwe (National Nuclear Regulator Act)

Isishunqulelo/ Isifinyezo	Ingcaciso
NOU	Iyunithi Esebenza Ngenyukliya
NRWDI	Iziko Lelizwe lenkcitho eneradiyeyishini ekhutshwayo (National Radioactive Waste Disposal Institute)
NSC	Inkqubo yokhuseleko lwenyukliya (Nuclear safety culture)
NSRB	Ibhodi Ehlola Ukhuseleko Lwenyukliya (Nuclear Safety Review Board)
PAZ	Ummandla Wokuthatha Amanyathelo Okuthintela (Precautionary Action Zone)
PID	Uxwebhu Lokwazisa Uwonke-wonke (Public Information Document)
PP	Iphepha Elicacisa Ukuma (Position Paper)
PSR	Uhlolo lokhuseleko lwamaxesha athile (Periodic Safety Review)
PWR	Iriyektha Yamanzi Axinzelelweyo (Pressurised Water Reactor)
RD	Amaxwebhu Ezinto Ezifunwa Yimimiselo (Regulatory Requirements Documents)
RG	Isikhokelo Semimiselo (Regulatory Guide)
SALTO	Iinkalo Zokhuseleko Zokusebenzisa Ixesha Elongezelelweyo (Safety Aspects of Long Term Operation)
SAR	Ingxelo Yokuhlalutywa Kokhuseleko (Safety Analysis Report)
SSCs	Oomatshini, izakhiwo, neekhomponenti (Systems. structures and components)
SSG	Isikhokelo sokhuseleko olungqalileyo (Specific safety guide)
SSRP	Imilinganiselo yokhuseleko noqheliselo lwemimiselo (Safety standards and regulatory practices)
Sv	I-sievert
TISF	Isakhiwo sexeshana esinguvimba (Transient interim storage facility)
TLAA	Uhlalutyo lokuguga olusikelwe ixesha (Time-limited ageing analysis)
TLD	I-thermo-luminescent dosimeter
UPZ	Ummandla wokucebela inyathelo elingxamisekileyo lokukhusela (Urgent protective action planning zone)
USNRC	Ikomishini Elawula Inyukliya eUnited States (United States Nuclear Regulatory Commission)

Isishunqulelo/ Isifinyezo	Ingcaciso
WANO	Umbutho Wehlabathi Wababhexeshi Benyukliya (World Association of Nuclear Operators)

4.3 Iimpawu Zekhompawundi

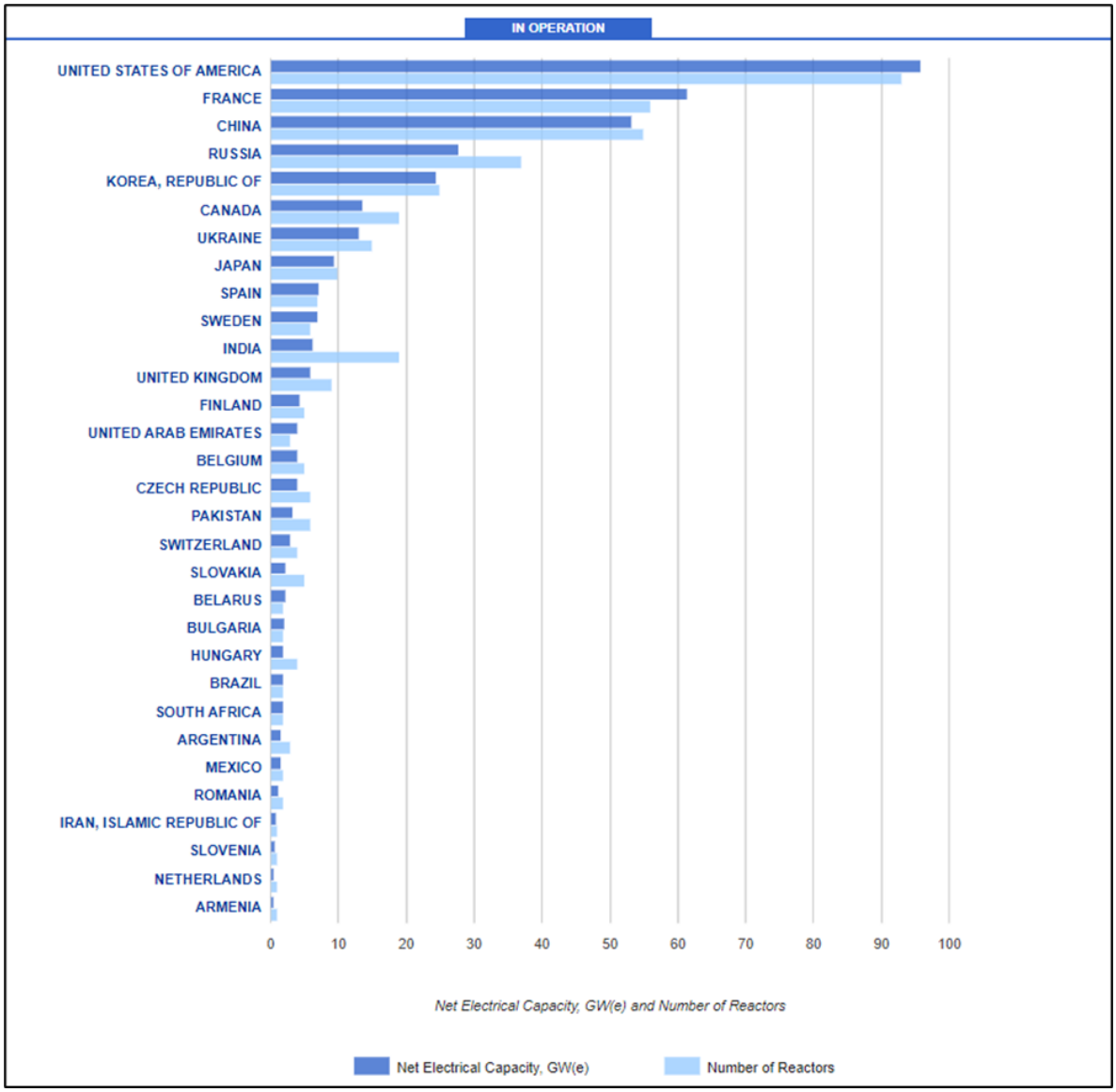
Ikhompawundi	Ingcaciso
UO_2	I-Uranium dioxide

5. IMVELAPHI YOKUSEBENZISA ISITISHI IXESHA ELONGEZELELWEYO

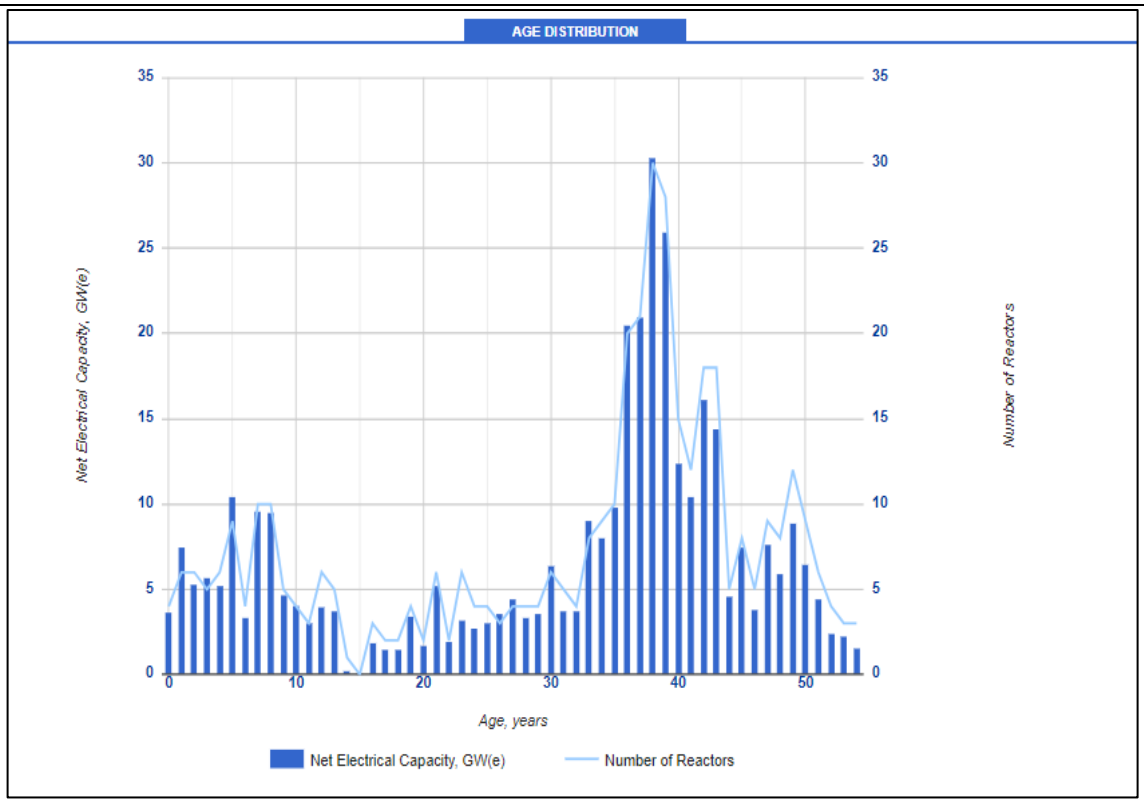
Ehlabathini jikelele, kuyinto eqhelekileyo ukongezwa kwexesha leelayisenisi zokusebenzisa izitishi zombane zenyukliya. Amava abonisa ukuba izitishi eziphehla umbane wenyukliya ezinjengeKoeberg zingakwazi ukubhexeshwa ngendlela ekhuselekileyo kangangeminyaka engaphezu ko-40. Ukongezwa kwexesha lokusebenzisa isitishi senyukliya kuyindlela eyonga iindleko, eyenza amazwe akwazi ukunikela ngamandla azinzileyo ngendlela enceda ekunciphiseni ukungcoliswa komoya yikhabhoni. Ukongezelela ekuphumezeni kweKoeberg indima ebalulekileyo kokusingqongileyo kuqoqosho loMzantsi Afrika, iKoeberg iza namathuba amahle engqesho yeengcali kubantu belizwe nabengingqi.

EMzantsi Afrika, iiyunithi ezimbini zenyukliya zaseKoeberg zikuphela kweeyunithi ezivelisa umbane osisiseko kwinxalenye esemazantsi elizwe. Zinceda ekuzinziseni igridi yombane yelizwe. Amandla avela kwinyukliya aneenzuzo ezininzi ezahlukileyo eMzantsi Afrika, kwaye kule meko ikhoyo, iLTO yaseKoeberg iza kunceda ekulibaziseni ukutyalwa kwemali eninzi kubuxhakaxhaka bokwakhiwa kwezitishi ezintsha zokuphehla umbane. Ngokuqhelekileyo iiprojekthi (projects) ezifana nale ezongeza ixesha lento ebisele ikho ziba nomngcipheko omncinane kunezifanayo eziqalwa phantsi, ngamanye amazwi xa kuqalwa phantsi ukwakhiwa. Ngokufanayo noko kuqheleke kwiimarike zehlabathi ezivelisa umbane, ukongeza ixesha lokusebenzisa isitishi sombane senyukliya eMzantsi Afrika kuyindlela eyonga iindleko yokufumana indlela yokuvelisa umbane osisiseko. Inyukliya ivelisa ikhabhoni (izinto ezingcolisa umoya) encinci esasazwa emoyeni kwaye iyafana neyokuphehla umbane kusetyenziswa umoya kule nkalo [15].

Umfanekiso 1 ubonisa inani leeyunithi zeriyektha zombane wenyukliya ezisebenzayo sithethanje kwilizwe ngalinye [3]. Zizonke ziyi-417 iiriyektha zenyukliya ezisebenzayo, neziyi-61 ezisakhiwayo. I-USA inezona yunithi zeriyektha zisebenzayo zininzi kwaye ziyi-94 zizonke, kulandele iFransi kunye neChina kwindawo yesibini eneeyunithi zeeriyektha eziyi-57.



Umfanekiso 1: Inani leeriyektha zombane wenyukliya nomthamo wombane eziwuvelisayo (GWe) ehlabathini. [3]



Umfanekiso 2: Imveliso yombane nobudala beyunithi yeriyektha yombane wenyukliya esebenzayo [3]

Umfanekiso 2 uchaza imveliso yombane nobudala beeyunithi zeeriyektha zombane wenyukliya ezisebenzayo [3]. Kukho iiriyektha zenyukliya eziyi-190 oko zisebenza iminyaka eyi-40 nangaphezulu, kwaye eyona riyektha indala isebenzayo ineminyaka engayi-56 isebenza (Nine Mile Point Unit 1 eNew York). Yagunyaziswa yiKomishini Elawula Inyukliya YaseUnited States (USNRC) ukuba yandise ixesha layo lokusebenza liye kwiminyaka eyi-60 ngo-2006. NgoJanuwari 2022, iUSNRC ibihlaziye iilayisenisi zokusebenzisa zeeyunithi zeeriyektha zombane wenyukliya eziyi-94. Iphinde yakhupha ezinye iilayisenisi ezihlaziyiweyo (ezandisa ixesha lokusebenzisa izitishi ukusuka kwiminyaka eyi-60 ukuya kwiminyaka eyi-80) kwiiriyektha zombane wenyukliya ezintandathu, kwaye ezinye ezisithoba zisaqwalaselwa [4].

EFransi, i-31 kwiiriyektha zombane wenyukliya eziyi-57 ezisebenzayo zineminyaka eyi-40 okanye ngaphezulu, kwaye iBugey-2 (eyona yunithi indala isebenzayo) yaqala ukuthululula umbane kwigridi yombane ngonyaka ka-1978 [3].

Njengoko kunjalo ngabalawuli benyukliya kumazwe ngamazwe, isigqibo seNNR sokugunyazisa okanye sokukhaba isicelo se-LTO sisekelwe ekubeni iKoeberg ikwazile na ukubonisa ukuba akukho mngcipheko ungafanelekanga kukhuseleko, impilo, okanye kokusingqongileyo nokuba imiqathango efunekayo echazwe kwimiyalelo ye-LTO [2] iye

yafezwa kwaye iza kuqhubeka ifezwa ebudeni be-LTO. Le iboniswa ngohlolo oluphelelelyo noluphangaleleyo lwemeko yangoku neyexesha elizayo loomatshini besitishi, izakhiwo kunye neekhomponenti ezenza umsebenzi obalulekileyo wokhuseleko. Uhlolo lumele lungqine ukuba iinkqubo neenkqubo, kuquka iinkqubo zokulawula ukuguga ezikhokela ukulawulwakoomatshini neekhomponenti zokusebenza ezinxibelelene nokhuseleko, ziyafikelela koku kufunwa yimimiselo.

Izicwangciso zokwandisa ixesha lokusetyenziswa kwezitishi zombane wenyukliya ziphandwa iminyaka emininzi (~iminyaka eyi-10 nangaphezulu) ngaphambi kokuphela kwexesha lelayisenisi ekhoyo ngoku. Zininzi izizathu zokwenza le nto; ngokomzekelo kusenokufuneka kutyalwe imali ekutshintsheni oomatshini neekhomponenti ezinkulu uphononongo namava omsebenzi abonisa ukuba ziyimfuneko ukuze ziqhubeke zisebenza ngendlela ekhuselekileyo nenokuthenjwa lonke ixesha leLTO. Oku kufuna ixesha lokuceba. Uphando lukaEskom malunga nokuba ingenzeka na iLTO lwaqala malunga no-2010, kwaye uthethathethwano lokuqala ne-NNR lwenzeka kamsinya emva koko, yaza i-IAEA yaqala ukubandakanyeka ngo- 2015.

Njengezikhululo zombane wenyukliya ezininzi zamazwe ngamazwe, iKoeberg iye yalungisa izinto ezininzi yaza yatshintsha izixhobo zokusebenza ezinkulu kule minyaka idlulileyo ukuze iqiniseke ukuba iqhubeka ikwimeko entle kwaye ingazuza kwithuba lokwandisa ixesha lokusebenza kwayo, ukuba i-NNR iyavuma. Zonke izinto eziphambili ezitshintshiweyo eKoeberg ngoku zigqityiwe, kuquka iinjineli zomphunga, iintloko zezikhongozeli ze reactor, kunye neetanki zokugcina amanzi okupholisa amafutha asetyenzisiweyo. Kwenziwe utshintsho nophuculo kwizinto eziliqela eKoeberg ukuze kusetyenziswe izinto esizifunde kwingozi yaseFukushima ezinjengeenjini ezingakumbi ezinokuhanjiswa ukuze zifake umbane kwizixhobo ezibalulekileyo, ukulungiselela omnye umthombo wamanzi okupholisa, kunye nezixhobo ezinokuhanjiswa zokususa inkcitho ebangelwe yinyikima.

Umfanekiso 3: Iinjini ezivelisa umphunga ezintsha zaseKoeberg ziyafika eMzantsi Afrika

6. ISISEKO SOMTHETHO NESAKHELO SEMIYALELO YE-LTO

Umthetho Womlawuli Wenyukliya Welizwe (NNRA) 47 wango-1999 unika i-NNR igunya lokunika okanye lokutshintsha isigunyaziso senyukliya (ilayisenisi zenyukliya) kwaye nelokulawulwa ngemiyalelo iindawo ezisebenza ngenyukliya ezinjengeKoeberg [35]. Inombolo yoMmiselo karhulumente, R.266, ophathelele iLTO [2], nesikhokelo semiyalelo ye-NNR LTO esihamba nayo [12], sichaza izinto ezifunekayo kwiLTO. UEskom kufuneka afake isicelo se- LTO ngokwecandelo 21(1) loMthetho We-NNR, kwaye isicelo kufuneka sixhaswe yingcaciso epheleleyo ngokhuseleko lwesitishi ukuze kuboniswe ukuba iKoeberg iza kuqhubeka isebenza ngendlela ekhuselekileyo ebudeni be-LTO. Isakhelo semiyalelo inkcitho eneradiyeyishini ekhutshwayo ichazwa kwicandelo 13.1 kolu xwebhu.

6.1 Uxwebhu olunengcaciso yokhuseleko exhasa isicelo se-LTO

Isicelo se-LTO sixhaswa luxwebhu olunengcaciso ngokhuseleko (safety case) oluthunyelwe kwi-NNR ukuze igunyaziswe. Ingcaciso ngokhuseleko iza nobungqina obubhaliweyo nezibakala ezibonisa ukuba akuyi kubakho mngcipheko ungeyomfuneko kukhuseleko, kwimpilo, okanye kokusingqongileyo ukuba iKoeberg ingaqhubeka isebenza iminyaka engaphaya kwe-20 emva kwexesha eyayilibekelwe kwilayisenisi leminyaka eyi-40. Ingcaciso ngokhuseleko isekelwe kwiintlolo zokhuseleko ezenziweyo ukuze kuxhaswe iLTO. Ngokuhambisana noko kufunwa yi-NNR, uhlolo lokhuseleko

lumele luquke i-PSR yaseKoeberg. I-PSR luhlolo oluneenkcukacha lweenkalo zokhuseleko eziyi-14 ukuze kubonwe izikhewu ezikhoyo ngokuphathelele izinto ezifunwa kukhuseleko ngamazwe ngamazwe, lilizwe, nemigaqo ekufuneka ilandelwe yokhuseleko ebekiweyo. Iinkalo zokhuseleko zidweliswe apha Itheyibhuli 1.

Itheyibhile 1: Uludwe lweenkalo zokhuseleko ezihloliweyo ebudeni bePSR yaseKoeberg

Umbandela	Inani	Umxholo wenkalo yokhuseleko
Isitishi	SF-1	Uyilo lwesitishi
	SF-2	Eyona meko yee-SSC
	SF-3	Ukufaneleka kweekhomponenti
	SF-4	Ukuguga
Uhlalutyo lokhuseleko	SF-5	Uhlalutyo lokhuseleko kwimiphumo engakho
	SF-6	Uhlolo lokhuseleko kwizinto ezinokwenzeka
	SF-7	Uhlalutyo lweengozi
Ingxelo yendlela ekuqhutywe ngayo namava okusebenza (OE)	SF-8	Indlela oluqhuba ngayo ukhuseleko
	SF-9	Ukusetyenziswa kwamava avela kwezinye izitishi nezinto ezifunyenwe kuphando
Ulawulo	SF-10	Umbutho, iinkqubo zolawulo, nenkqubo yokhuseleko
	SF-11	Iinkqubo ezilandelwayo ezibhaliweyo
	SF-12	Iinkalo zabantu
	SF-13	Ukucebela imeko yongxamiseko
Okusingqongileyo	SF-14	Ifuthe leradiyeyishini kokusingqongileyo

Ngokutsho kweIAEA, iiPSR ziyindlela esebenzayo yokwenza uhlolo jikelele lokhuseleko lwesitishi. Olu hlolo lusetyenziswa njengendlela yokugqiba enoba isitishi sombane wenyukliya siyafaneleka na ukusetyenziswa ixesha elingaphaya kweminyaka eyi-40 esasiyibekelwe ekuqaleni. I-PSR kuthethwa ngayo ngakumbi kwicandelo 11.4.

Uqheliselo neenkqubo ezisebenzayo zokulawula ukuguga zingayithintela imiphumo emibi ingachaphazeli ukuthembeka koomatshini besi sitishi ebudeni bexesha leLTO. Ukuthatha inxaxheba kweKoeberg, nokusebenzisana kwayo, nemibutho yamazwe ngamazwe

enjengoMbutho Wehlabathi Wababhexeshi Benyukliya (WANO), iÉlectricité de France (EDF), iElectric Power Research Institute (EPRI), i-IAEA, neminye emininzi kunenzuzo ezibalulekileyo kwiKoeberg. Ezi nzuzo ziquka ukufumaneka kwamava amaninzi okusebenza, izinto ezifundwayo xa kusenziwa umsebenzi, kunye namava ngokukodwa kwiinkqubo zokuguga neenkqubo zokulawula ukuguga (eyona nto lujoliswe kuyo uhlolo lweLTO) kunye nokufikelela kwiingcali zezitishi zenyukliya ngophononongo loontanga. La mava afakwa kwiinkqubo zokulungisa nokuhlola iKoeberg ukuze kulawulwe okanye kupheliswe imiphumo yokuguga kwiiSSC kwaye kuphuculwe ukhuseleko xa kusetyenzwa nendlela eqhuba ngayo iKoeberg.

UMzantsi Afrika ucele i-IAEA ukuba iqhube uphononongo loontanga lweSALTO. Isizathu sokukhetha uphononongo loontanga lweIAEA, phakathi kwezinye, kukuba imiqathango efunwa yiIAEA ifana kakhulu nemiqathango efunwa lilizwe kwiLTO kwaye iquka ezona zenzo zifanelekileyo ezenziwa kumazwe ngamazwe. Ngoko ke, eli phulo linike iKoeberg ithuba lokwamkela indlela efanelekileyo neqinisekisiweyo yokulungiselela iLTO ekhuselekileyo. Ububanzi obuqulathwe luphononongo loontanga lweSALTO bubonisiwe kwiItheyibhuli 2.

Itheyibhile 2: Ububanzi obuqulathwe luphononongo loontanga lweSALTO

Indawo	Umxholo	Ingcaciso
A	Inkampani nemisebenzi, isiseko selayisenisi yangoku, ulawulo lohlengahlengiso/lotshintsho	Ukujonga isakhono senkampani sokulawula iLTO ngokwenkqubo-mgaqo yolawulo, iinkqubo ezilandelwayo ezibhaliweyo, iinkqubo, iindima, neembopheleleko.
B	Ububanzi nokuhluza neenkqubo zesitishi ezinento yokwenza neLTO	Ukugqiba ngendlela nezinto ezijongwayo xa kukhethwa iiSSC kulawulo lokuguga. Ukuqinisekisa enoba iinkqubo zesitishi ezinjengeenkqubo zokulungisa nezokuhlola ziyifanele iLTO.
C	Uhlolo lolawulo lokuguga, ukuhlolwa kweenkqubo zokulawula ukuguga (AMP), nohlalutyo lokuguga okusikelwe ixesha (TLAA) kwiikhomponenti zoomatshini	Ukuhlola ukuba ziyasebenza yaye ziphelele na iinkqubo zokulawula ukuguga zeeSSC zoomatshini ezibalulekileyo kukhuseleko.
D	Uhlolo lolawulo lokuguga, ukuhlolwa kwee-AMP, nee-TLAA ezinxulumeneyo zeekhomponenti ezisebenza ngombane ne-I&C	Ukuhlola ukuba ziyasebenza yaye ziphelele na inkqubo zokulawula ukuguga zeeSSC ezisebenza ngombane, ezeeinstrumenti, nezokulawula ezibalulekileyo kukhuseleko.

E	Ukuhlola ulawulo lokuguga, ukuhlola ii-AMP, nee-TLAA ezinxulumeneyo zezakhiwo	Ukuhlola ukuba ziyasebenza yaye ziphelele na inkqubo zokulawula ukuguga zeeSSC zezakhiwo ezibalulekileyo kukhuseleko.
F	Abasebenzi, ubuchule, nolawulo lolwazi kwiLTO	Ukujonga enoba izicwangciso zokuqesha abasebenzi, iinkqubo, namanyathelo alandelwayo ziyahlangabezana nemfuneko yabasebenzi abaneleyo abakwaziyo ukusebenza ngexesha leLTO.

IKoeberg ikwazile ukusebenzisa amava enawo okusebenza anxulumene nokuguga kwee-SSC neenkqubo zokulawula inkampani ukuze zisebenze kwiLTO phambi kweengcali zamazwe ngamazwe kwiinkalo zazo. Emva kokugqitywa komsebenzi we-SALTO, iziphumo zohlalutyo zabelwana ngazo ne-NNR kunye noluntu.

Ukuze kuboniswe ukuba iLTO iza kukhuseleka, kuye kuqwalaselwe ngokukhethekileyo ulawulo olufanelekileyo lweenkqubo zokuguga ezinokuchaphazela iiSSC zesitishi ezibalulekileyo kukhuseleko. Ukujolisa kulawulo lokuguga kwenzelwa ukuqinisekisa ukuba iiSSC ziza kuqhubeka zikwazi ukwenza imisebenzi yazo yokhuseleko ebudeni balo lonke ixesha elicetyiweyo leLTO.

Le PID iqulethe ulwazi olufanelekileyo olugcinwe kwityesi eluqilima. Okubalulekileyo nokuqulathwe kwingcaciso yokhuseleko exhasa isicelo selayisenisi yeLTO nokwanelisa izinto ezifunwa ku-R.266 [2] nesikhokelo semiyalelo ye-NNR kwiLTO [12] koku kulandelayo:

- Ingcaciso edibene nesiza (ekuthethwa ngayo kwiSahluko 8 kule PID)
- Imingcipheko kukhuseleko, impilo, nokusingqongileyo (Isahluko 10)
- Uhlolo lokufaneleka koyilo lwesitishi (plant design) kwiLTO (icandelo 11.1)
- Uhlolo lweyona meko zikuyo iiSSC (icandelo 11.2)
- Ulawulo lwezixhobo ezigugayo zeplanti, neziphumo zephulo lokuxhasa leIAEA kwiSALTO kwiinkalo zokhuseleko lokusebenzisa ixesha elongezelelweyo (iSALTO) icandelo 11.3
- Iziphumo zePSR yakutshanje, eqhutywa qho emva kweminyaka eyi-10 zaye zafakwa kwiNNR ngoJuni 2022 (icandelo 11.4)
- Ifuthe leLTO kwezi nkqubo zilandelayo:
- Amalungiselelo nokusebenza kokhuselo kwiradiyeyishini (icandelo 11.5)
- Ukhuseleko kwinyukliya (nuclear security) icandelo 11.6)

- Ukucebela imo yongxamiseko (icandelo 11.7)
- Ukulawulwa kwenkcitho eneradiyeyishini (Isahluko 13)
- Amalungiselelo enkampani eLTO anjengeenkqubo zolawulo, ulawulo lolwazi, abasebenzi nobuchule babasebenzi, imali, imibutho exhasayo yangaphandle (Isahluko 12)
- Ukwanela kwenkqubo yokhuseleko lwenyukliya (nuclear safety culture) eKoeberg
- (icandelo 12.5)
- Ububanzi nobume bemisebenzi ebalulekileyo kwiLTO (ezingaphambi kwexesha leLTO, nangexesha iqhubeka iLTO) (icandelo 15)

Njengenxalenye yengcaciso yokhuseleko, isicwangciso sokuphumeza iLTO sanikwa iNNR ukucacisa malunga nophuculo oludingekayo kwenziwa ngaphambi I-LTO, kwakunye nezo zicwangcisiweyo nasebudeni beLTO ukuze kuqinisekiswe ukuba kusetyenzwa ngendlela ekhuselekileyo kulo lonke ixesha leLTO. Ngokusekelwe koku kungentla, ingcaciso yokhuseleko ibonisa ukuba iza kuqhubeka isebenza ngokukhuselekileyo eminye iminyaka eyi-20 kwaye iyangqina ukuba akukho mngcipheko ungafanelekanga kukhuseleko, impilo, okanye kokusingqongileyo.

Ingcaciso yokhuseleko yaqulunqwa yaza yahlolwa yodwa liqela leenjineli ezinamava (zeli nezamazwe ngamazwe) ngaphambi kokuba ithiwe thaca kwiikomiti eziphethe ukhuseleko lweKoeberg ukuze zivumelane nayo. Ukuze kuqinisekiswe ukuba zonke iinkalo zokhuseleko ziye zaqwalaselwa kwingcaciso yokhuseleko, iphinda ihlolwe liqela leengcali ezinamava kakhulu kwinyukliya zeli nezamazwe ngamazwe ngaphambi kokuba ifakwe kwiNNR. Ekugqibeleni, ifakwa kwiNNR ukuze yenze isigqibo ngesicelo seLTO.

6.2 Imiqathango ekhoyo ngoku yelayisenisi nesiseko selayisenisi

ILayisenisi Yesitishi Senyukliya YaseKoeberg esebenza ngoku (NIL-01 uhlelo 21) [1] ikhutshwe ngokwecandelo 21 loMthetho Womlawuli Wenyukliya Welizwe [35]. I-NIL-01 utshintsho 21 isebenza ukuya kumhla we-9 Novemba 2025 yeYunithi 2, emva koku kufuneka ihlaziyelwe amanqanaba elayisenisi alandelayo, aquka iLTO. I-NIL-01 ikhutshwe yiNNR ngokuxhomekeke kwimiqathango ekufuneka iKoeberg iyithobele, ngoku nasebudeni balo lonke ixesha leLTO. Le miqathango ngokuyintloko isekelwe kwimigaqo ebekwe yi-IAEA kukhuseleko ebeka imigangatho ephakamileyo yokhuseleko lwenyukliya.

IKoeberg iqhuba ikujonga ngokwayo ukuthotyelwa kwemiqathango yeNIL-01, noxa iNNR yona ibeka imiyalelo ezimeleyo yokujonga ukuze ibeke esweni ukuthobela kweKoeberg imiqathango yeNIL-01. Le yeyona ndlela isebenzayo yokuqinisekisa ukuba kusetyenzwa ngendlela ekhuselekileyo ngokuthobela ngokungqongqo imigangatho ephezulu

yokhuseleko nemiqathango yelayisenisi. Ikopi yeNIL-01 iyafumaneka kuluntu kwaye inokufumaneka kwiwebhusayithi yeNNR.

Imiqathango ekhethiweyo yeNIL-01 ekufuneka ithotyelwe nesebenzayo kwiLTO idweliswe ngezantsi. Ezi ziimbalasane ezixhaswa ngamaxwebhu ahlukeneyo elayisenisi, amaxwebhu emiyalelo, nemigangatho yelizwe neyamazwe ngamazwe echaza ngokweenkcukacha izinto ezifunekayo nezinto ezijongwayo, xa kuyimfuneko. Imiqathango yelayisenisi ishwankathelwe ukuze ibe lula kwaye kube lula nokuyiqonda kwaye ayiloludwe olupheleleyo lwayo yonke imiqathango yelayisenisi.

- Ukukhuselwa kwabantu kwiradiyeyishini – iKoeberg imele iqiniseke ukuba iidowusi zeradiyeyishini engena ebantwini (abasebenzi nowonke-wonke) azigqithi kwisisikelo esibekwe yiNNR.
- Ukukhuselwa kokusingqongileyo nokulawulwa kwamanzi amdaka alahlwayo – iKoeberg imele ibeke esweni kwaye ilawule ukuchithwa kwamanzi amdaka aneradiyeyishini (amanzi nerhasi) kwimida echazwe yiNNR.
- Inkcitho eneradiyeyishini ekhutshwayo – iKoeberg imele iqiniseke ukuba inkcitho eneradiyeyishini ekhutshwayo iyancitshiswa, igcinwa ngendlela ekhuselekileyo, ize ilahlwe okanye isetyenziswe ngokutsha.
- Ukucebela nokulungela imeko yongxamiseko yengozi yenyukliya – iKoeberg imele iqiniseke ukuba isicwangciso semeko yongxamiseko yengozi yenyukliya siyaqulunqwa, siqheliselwe, size sivavanywe.
- Ukubekwa esweni ngabezamayeza nerejista yempilo – iKoeberg imele iqiniseke ukuba bonke abasebenzi, kuquka iikhontraktha ezibandakanyeke kwizinto ezenziwayo ezichaphazela ukhuseleko lwenyukliya, zisempilweni ngokwaneleyo ukuze zenze umsebenzi.
- Uhlolo lokhuseleko – iKoeberg imele ijonge, ihlole ize iphinde iqwalasele ukhuseleko ebudeni bawo onke amanqanaba omjikelo wobomi bayo. I-PSR imele yenziwe qho kwiminyaka eyi-10 kwaye ifakwe kwiNNR.
- Utshintsho kwisitishi – iKoeberg imele ifumane isigunyaziso kwiNNR salo lonke utshintsho oluchaphazela ukhuseleko lwenyukliya kwesi sitishi.
- Ukulungisa nokuhlola – iKoeberg imele iqiniseke ukuba iiSSC ziyalungiswa zize zihlolwe ukuze kuqinisekiswe ukuba ziyakwazi ukuwufeza umsebenzi wazo wokhuseleko. Ukulungisa, ukuhlola, nokuvavanya kumele kwenziwe ngabantu abafunde baqeqeshwa ngokufanelekileyo.
- Ulawulo lokuguga neLTO – iKoeberg imele iqiniseke kuba kuqulunqwa, kuphunyezwe, kuze kugcinwe inkqubo esebenzayo yokulawula ukuguga ukuze kuqinisekiswe

ukuba imisebenzi yokhuseleko eyenziwa ziiSSC isoloko ikho ngalo lonke ixesha lokusebenza kwayo.

- Ukuphelisa ugunyaziso lwesitishi – iKoeberg imele ibonise iNNR ukuba kuza kubakho abasebenzi nemali eyaneleyo ngalo lonke ixesha lokuphelisa ugunyaziso lwesitishi kwayo.
- Ukhuseleko loqobo– iKoeberg imele iqiniseke ukuba isiza, isitishi, nabantu abangaphakathi kwesiza eKoeberg bakhuselekile.
- Abantu abagunyazisiweyo nabafanelekileyo – iKoeberg imele iqiniseke ukuba ngabantu abafanelekileyo nabanamava kuphela abenza imisebenzi enokuchaphazela ukusebenza ngendlela ekhuselekileyo.
- Ulawulo lomgangatho nokhuseleko – iKoeberg imele isebenzise inkqubo edityanisiweyo yokulawula umgangatho nokhuseleko kunye nenkqubo yenkqubo yokhuseleko lwenyukliya.

IKoeberg iye yasungula iinkqubo zenkampani, iinkqubo namanyathelo alandelwayo athelekiswa nemigangatho yelizwe neyamazwe ngamazwe ukuze ihambisane nale miqathango yelayisenisi ingentla. Ukuthotyelwa kwezi nkqubo, namanyathelo alandelwayo kubekwa esweni ngophicotho lwangaphakathi lweSebe Eliqinisekisa Umgangatho LaseKoeberg (kulandelwa isicwangciso sokuphicotha esenziwa unyaka nonyaka), ngeengxelo ezenziwa minyaka le zolawulo ezivela kwiSebe Eliqinisekisa Ngokhuseleko LaseKoeberg, uhlolo lwangaphandle olunjengohlolo loontanga lweWANO, iBhodi Ehlola Ukhuseleko Lwenyukliya (NSRB), nokuhlolwa qho yiNNR. Iqela lamanyathelo alandelwayo neenkqubo ezithobela imiqathango yeNIL-01 libhalwe kwimanyuwali yesiseko sokunikwa ilayisenisi kweKoeberg.

Inkqubo yokufaka iingxelo ikho ngokuhambisana noko kufunwa yilayisenisi. IKoeberg kufuneka ithumele iingxelo kwiNNR ngemiba eliqela suku ngalunye, veki nganye, nyanga nganye, okanye nyaka ngamnye, kuxhomekeka kuhlobo lwento nefuthe enganalo ekusebenzeni ngendlela ekhuselekileyo. Ukufakwa kweengxelo qho kubangela ukuba kungafihlwa nto kwaye abantu baphenduliswe, kwaye iqhelekile loo nto kwizitishi zenyukliya.

Ulawulo lweNNR olunjongo yalo ikukuqinisekisa ukuba imiqathango yelayisenisi ye-Koeberg NIL-01 iyafezekiswa kwaye iza kuqhubeka ifezekiswa ebudeni bexesha leLTO kuza kuthethwa ngayo kwicandelo elilandelayo.

6.3 Ukongamela kweNNR – ukuthobela imiyalelo nokuyinyanzelisa

IKoeberg inoxanduva lokhuseleko lwenyukliya, noxa iNNR inoxanduva lokuchaza izinto ezifunekayo ukuze kubekho ukhuseleko lwenyukliya kwaye isongamela umsebenzi. Njengoko kuchaziwe kwiwebhusayithi yeNNR, iNNR inikwe umsebenzi wokubeka esweni nowokunyanzelisa imigangatho yokhuseleko efunwa yimiyalelo ukuze kusetyenzwe ngendlela ekhuselekileyo, kuthintelwe iingozi zenyukliya, okanye kuncitshiswe imiphumo yengozi yenyukliya, ize loo nto iphumele ekubeni abasebenzi, uwonke-wonke, iipropati, nokusingqongileyo zikhuseleke kwimiphumo engayingozi yeradiyeyishini efaka i-ion okanye yezinto ezineradiyeyishini.

IKoeberg kulindeleke ukuba iphumeze inkqubo yokuhlola ukuze iqiniseke ukuba iyathotyelwa imiqathango ekwiNIL-01. I-NNR isebenzisa inkqubo ezimeleyo yokongamela enamanyathelo angqongqo okuthobela nokunyanzelisa. I-NNR yenza izinto eziqinisekisa ukuthobela ukuze ibone ukuba iKoeberg iyithobela kangakanani imiqathango yeNIL-01. Izinto eziqinisekisa ukuthobela zibandakanya intlanganisela yophicotho, uhlolo olwenziwa ngamaxesha athile, uhlolo olwenziwa nanini na, ukuqwalaselwa kweengxelo ezenziwa ngamaxesha athile, nokuqwalaselwa kweengxelo zeziganeko.

Xa kufumaniseka ukuba kukho ukungathotyelwa kwemiqathango, iNNR inokuqalisa izenzo zokunyanzelisa ukuthobela. Izenzo zokunyanzelisa ukuthobela zenzelwe ukusabela xa ingathotyelwa imiqathango nezinto ezifunekayo ezichaziweyo. Izenzo zokunyanzelisa ukuthobela ziye zilingane nobungakanani bokwaphulwa komqathango kwaye zingazizilumkiso ezibhaliweyo, izohlwayo, ukunqandwa komsebenzi, ukunqunyanyiswa kogunyaziso, okanye – ekugqibeleni – ukurhoxiswa kogunyaziso. Kuzo zonke iimeko, uEskom, umnini-gunya, umele alungise oko kungathobeli ngokwenza uphando olucokisayo ngexesha ekuvunyelwene ngalo kwaye athathe onke amanyathelo ayimfuneko ukuze inqandwe ingaphinde yenzeke loo nto.

Ukongamela kakuhle kweNNR kuye kwafaka isandla ekuqhubekeni kweKoeberg isebenza ngendlela ekhuselekileyo kuyo yonke le minyaka idlulileyo. Inkqubo yemiyalelo nokongamela kweNNR, kunye neminye imiyalelo esacingwayo malunga nezinto ezifunekayo kwiLTO, ziza kuqhubeka zisebenza ebudeni beLTO.

7. INKCAZELO YOMFAKI-SICELO

Igama elipheleleyo lomfaki-sicelo	Eskom Holdings SOC Limited
Idilesi yendawo	Megawatt Park Maxwell Drive Sunninghill 2157
Inombolo yobhaliso yenkampani	2002/015527/30
Umhla wokubhaliswa	2002
Iadresi ebhalisiweyo	PO Box 1091 Johannesburg 2000
Idilesi yendawo yesitishi senyukliya	R27 off West Coast Road, Melkbosstrand, Western Cape, 7441 Esi siza simalunga neekhilomitha eziyi-27 kumntla weKapa eNtshona Koloni. EKoeberg ungena ngo-R27 kungenjalo nge-Otto du Plessis Drive. IKoeberg ikwiFama YaseDuynefontyn 1552.
Inkcukacha zazo naziphi iinkampani ezingabanini okanye ezingamahlakani ale	UEskom Holdings SOC Limited ngokarhulumente ngokupheleleyo.
Iinkcukacha zokubandakanyeka kwelinye ilizwe okanye zokulawulwa kwezitishi zenyukliya ngamaqumrhu /oorhulumente bangaphandle (bamanye amazwe)	Akukho mfuneko yazo (N/A)

8. INKCAZELO NGESIZA

IKoeberg ikwiPhondo LaseNtshona Koloni kwiSithili SaseBlaauwberg soMasipala Ombaxa WesiXeko SaseKapa, malunga neekhilomitha eziyi-27 kumntla weKapa. Ikwisiza esikwifama yaseKapa iDuynefontyn 1552 (kudityaniswe ifama yaseKapa iDuynefontyn 34 neFama 1375) kunye nefama emelene nayo iKleine Springfontyn 33. Esi siza sonke sesikaEskom, kwaye sijikelezwe liziko lokulondoloza indalo elinomnini walo. YiWitzands Aquifer Nature Reserve kumntla mpuma, kwaye yindawo ehlala abantu iDuynefontein emzantsi ize ibe luLwandle LweAtlantiki entshona.

U-R27, owaziwa ngokuba yiWest Coast Road, yindlela yelizwe eya kwicala lomntla nomzantsi kunye nomntla ntshona kumda osempuma wesi siza. Indlela eyintloko yokungena isuka ku- R27 iye eKoeberg kwaye ikhona nenye indlela yokungena ngeDuynefontein emzantsi.

Isiza saseDuynefontyn, ekuso iKoeberg ihlahlelwe ngokufanelekileyo njengeyokuvelisa umbane ngenyukliya nemisebenzi edibene naleyo.

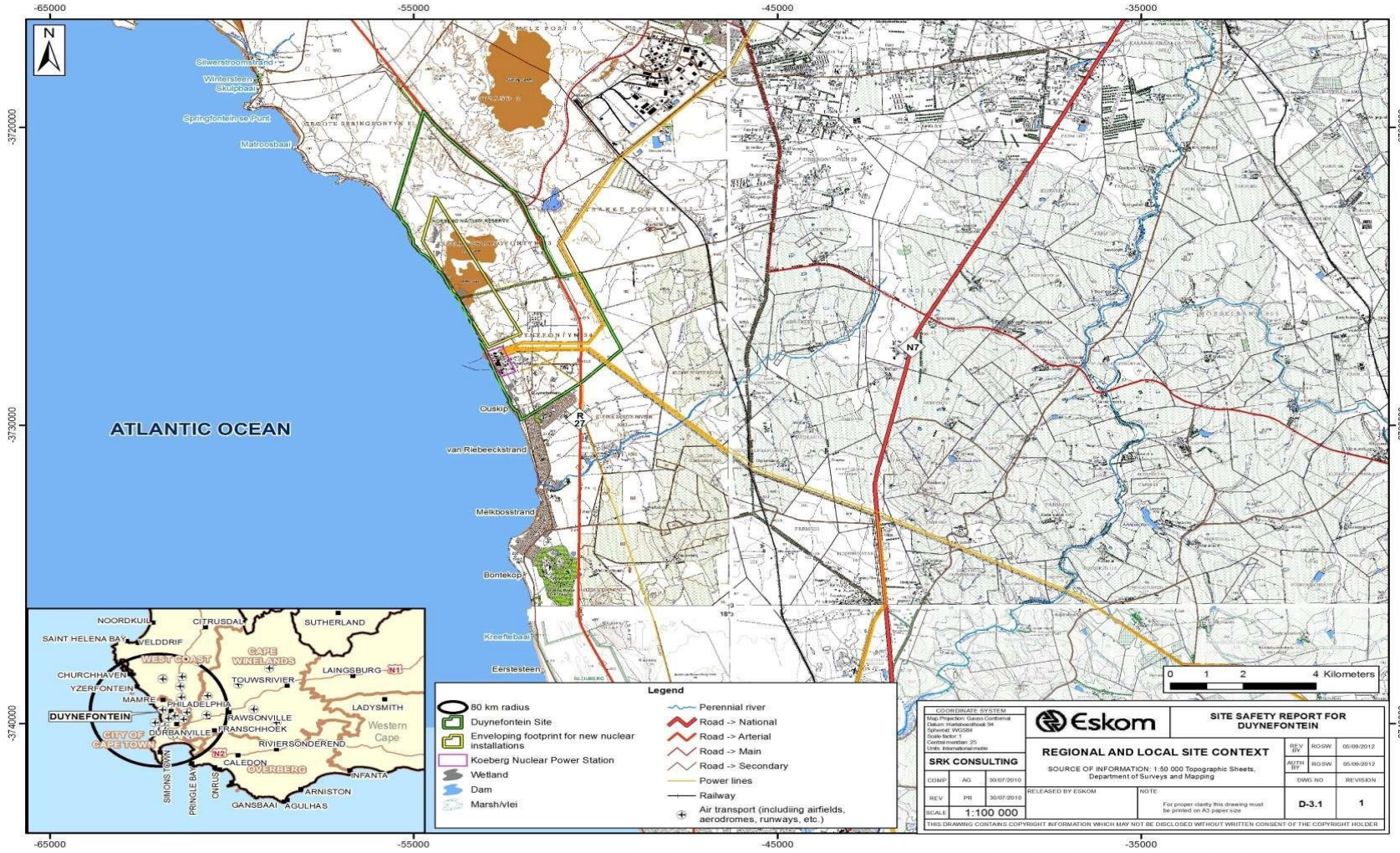
IKoeberg lilo lodwa iziko lamandla elingu-*base load* elikwiNtshona Koloni, kwakunye namanye amaziko amancinanana anamandla angu-*peaking*. IKoeberg iqhakamshelwe kwiziko lokuphehla elikhulu eliseMpumalanga ngobuxhakaxhaka begridi yesizwe (national) bokuhambisa umbane esebenzisa 400 kV ne765 kV. Ukuba iKoeberg ibingasebenzi, bekuya kulahleka umbane omninzi njengoko kusenzeka xa kuhanjiswa umbane kule migama mide. Iintambo zombane ze-400 kV zidibanisa le ndawo negridi yelizwe kunye nomthombo oyintloko wombane oseMpumalanga, kwaye iKoeberg ifaka umbane kwigridi ukuze usetyenziswe ekuhlaleni ize iwuthumele kwinkqubo yegridi, kuxhomekeka ekubeni ingakanani imfuneko yawo.

IKoeberg ifumana amanzi kwisiXeko SaseKapa kunye nendawo yaseBloubergstrand, eMelkbosstrand, eVan Riebeeckstrand neDuynefontein ngemibhobho yamanzi evela kwiDama LaseVoelvlei eliphakathi kweHermon neTulbagh, nakuVimba Wamanzi WaseMelkbos oziimitha eziyi-40 000 m^3.

Akukho milambo kwisiza ngokwaso kodwa kukho imigxobhozo ebalulekileyo kwizityalo nezilwanyana xa usiya kumzantsi weKoeberg nakwinxalenye esemantla esiza.

Esona sikhululo seenqwelo-moya sikhulu sikufutshane siSikhululo Seenqwelo-moya Samazwe Ngamazwe SaseKapa, esikwiikhilomitha eziyi-40 kumzantsi-mpuma. Isiporo sikaloliwe oya eNamaqualand esidlula malunga neekhilomitha eziyi-24 kwimpuma yesi siza sesona siporo sikaloliwe sikufutshane kwesi siza.

IChweba LaseKapa (kwiikhilomitha eziyi-25 emzantsi) lelona chweba likhulu lezorhwebo kule ngingqi, kwaye iChweba LaseYzerfontein, ichweba lezikephe ezincinane, likwiikhilomitha eziyi-25 xa usiya kumntla ntshona. Esi siza xa usijonga ngokwengingqi siboniswe kuMfanekiso 4



Umfanekiso 4: Isiza xa usijonga ngokwengingqi nasekuhlaleni

YEKAWONKE-WONKE

8.1 Ukufaneleka kweziko

Eli ziko laseDuynefontyn, apho ikhoyo iKoeberg, lithe lahlolwa kakhulu ekuqhubekeni kweminyaka kukhangelwa ubuthathaka balo xa kunokuvela iingozi ezinjengeenyikima neetsunami. Ukuphonononga iimpawu zeli ziko ezinokuchaphazela ukhuseleko lweKoeberg, zize zibe negalelo kusasazo lweradiyeyishini ebantwini nakokusingqongileyo kuquka, phakathi kwezinye izinto:

- olokuma komhlaba, ukunyikima komhlaba, uhlobo lomhlaba, amanzi, nemozulu;
- ukuqwalaselwa kotshintsho kwimozulu;
- ukwanda kwabemi nokusasazeka kwabo;
- ukusetyenziswa komhlaba nolwandle olumelene nesiza;
- izakhiwo ezikufutshane zezothutho, zemizi-mveliso nezomkhosi; kunye
- nefuthe elinokubakho leradiyeyishini kubantu nakokusingqongileyo.

Uphononongo lokuhlola isiza lubonise ukuba, ngokusekelwe kwinkcazelo efumanekayo ukuza kuthi ga namhlanje azikho izinto ezifunyenweyo eziyenza ingafanelekeli ukuqhubeka isetyenziselwa inyukliya. Idizayini ekhoyo yeKoeberg yomelele ingamelana neenyikima, umoya onamandla, iitsunami, ukuchitheka kweoyile elwandle, iijelifishi, iinqwelo-moya eziwayo, njalonjalo kwicandelo 10.1.3 ulawulo lweengozi. La maphulo okuvavanya amaziko ayahlaziywa ngoku, kujongwe kwizifundo, phantsi kohlolisiso lokulawula ezifunyenwe kwisiganeko saseFukushima, kuqinisekiswa olona hlaziyo lutsha nokuliqonda ngokuchanekileyo iziko elo, kube kusetyenziswa ulwazi, imithetho elawulayo, kunye neendlela zangoku zokuhlalutya.

Uphononongo lokuhlola isiza lwenziwa kusetyenziswa imimiselo yamazwe ngamazwe, yelizwe kunye nemiqathango yemiyalelo yokhuseleko, equka Imimiselo Yokunika Isiza Ilayisenisi) [17], Isikhokelo Sexeshana Seziza Zezakhiwo Zenyukliya [18], Ukuhlolwa Kweziza Zezitishi Zenyukliya KweIAEA [19]. Olu phando, neziphumo zalo, azijonganga kubomi obuminyaka iyi-40, kodwa lolokuphononongo ngeendlela ezintsha zokuphanda ukuba akukho ngozi zintsha ezinokuchaphazela iziko eli.

Kubhaqeke ukuba utshintsho kwiipateni zemozulu olunokuba nobungozi lolu lokunyuka kwamaqondo obushushu kumanzi olwandle. Kodwa nokuba kunjalo, amacandelo eKoeberg apholisa ngokusebenzisa amanzi olwandle adizayinelwe ukumelana namaqondo obushushu aphezulu olwandle.

Uhlaziyo lovavanyo lweziko, yonke imingcipheko emitsha yeengozi eKoeberg iza kuhlolwa. I-Eskom ihlalutya iimpembelelo zezifundo ezihlaziyiweyo zokusebenza

ngokukhuselekileyo kweKoeberg, ngalo lonke ixesha le-LTO (oko kukuthi, uvavanyo aludingeki ngaphambi kwe-LTO, kodwa ukuqhubeka nokuqina ngexesha le-LTO kubandakanya notshintsho lwemozulu). Olu hlolo luza kuveza ukuba idizayini neenkqubo zokusebenza zisemgangathweni na ukumelana neengozi ezinokwehla, okanye kuza kufuneka kongezwe izithintelo ezitsha, ngokokubaluleka kokhuseleko nemigaqo-nkqubo emitsha.

Ingxelo yokuhlolwa kweziko iyagqityezelwa inikezelwe kwiNNR ngo2024, Ukuphuculwa kweziko, ukuhlola nokuphucula iindlela zokusebenza sekusenzeka, ukuze iKoeberg ikwazi ngakumbi ukumelana neemeko zangaphandle, kwande nokhuseleko:

- Ukongezwa kwemiphako yeejenereyitha zombane, neendawo zokukonektha kulungiselelwa xa kuthi kumke amandla ombane, ube umkile nalo wokusindleka.
- Izixhobo zokuthutha umhlaba nobugoxo xa kwehle inyikima, umzekelo
- Ukuphucula iindlela zokwenza ukuhlangabezana nengozi yenyukliya enokwenzeka, nangona kunqabile oko
- Ukongeza iimpompo zokupholisa nokujikelezisa ubushushu kwiipuli zokugcina ifuweli eseyisebenzile (*spent fuel pools)*
- Iimpompo eziphathwayo ezinamandla ombane apha kuzo eziza kongeza amanzi okupholisa ii-*spent fuel pools* nezakhiwo zokugquma
- Ukuphucula izixhobo zeziko kwaneendlela zokwenza ukunqanda ukungena kweejelifishi ne-oyile echitheke elwandle kwisitya sokukhongozela
- Ukufakela ii-*passive autocatalytic recombiners* zokukhupha ihayidrojini ukuba kungenzeka ingozi, ukuze kuthinteleke uqhushumbo
- Kwakhiwa amatanki amatsha amanzi nemibhobho ukuze kuphoziswe iriekta . Ezi ziitanki ezongezelelweyo, ezifanelekileyo ngokunyikima komhlaba kwaye ezakhiwe ngoku.

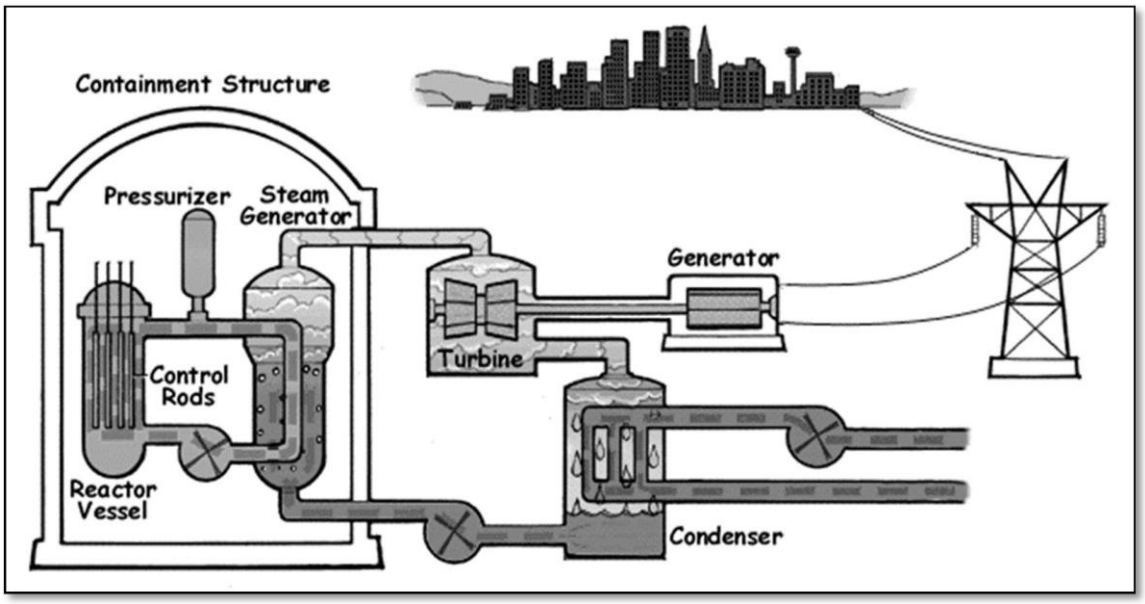
Ngokwamava amazwe ngamazwe anjengengozi yaseFukushima, kwimigomo yokuthintela umonakalo omkhulu xa kwenzeke iingozi ezinjengeenyikima neetsunami kungabalwa iindlela zokuphehla umbane ozimele geqe, nokuhambisa amanzi okuphozisa, nokukhutshwa kwehayidrojini egciniweyo, kwanezicwangciso zokulawula ixesha likaxakeka. Njengoko sekutshiwo apha ngentla, sewenziwe eKoeberg umsebenzi omninzi kule mibandela, kanti sekukho ezicwangcisiweyo zokuwandisa ngexesha leLTO.

9. INGCACISO YEMISEBENZI EYENZIWA NGOKU EKOEBERG

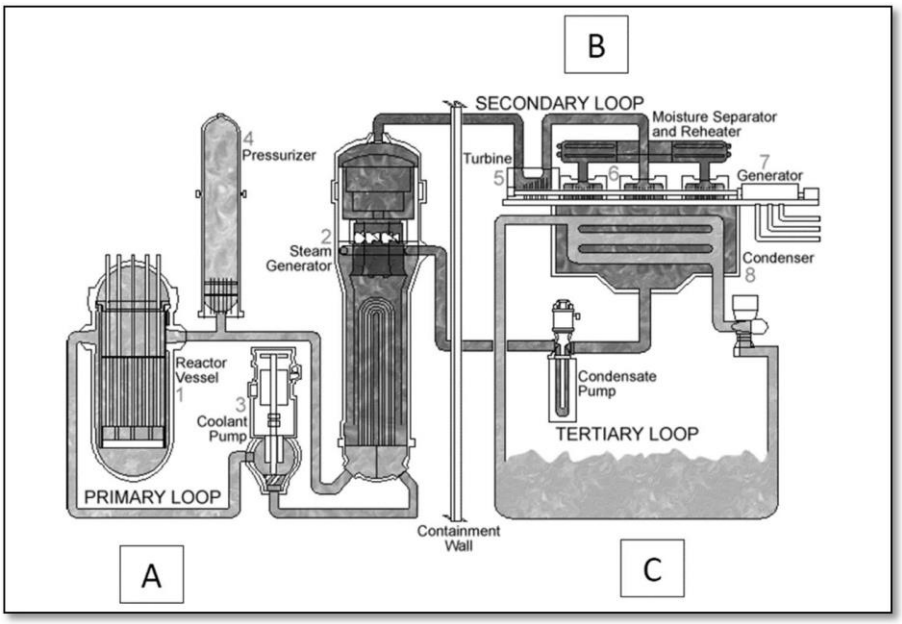
Eli candelo lisinika amagqabantshintshi emisebenzi eyenziwa eKoeberg.

9.1 Isitishi Senyukliya Sokuphehla Umbane SaseKoeberg

Uyilo lweKoeberg alufani lodwa. Luyafana nolwezinye iiyunithi zeeriyektha zenyukliya ezisehlabathini jikelele (ngokukodwa eFransi) kwaye uyilo lwayo luyafana nolwezinye iiyunithi zeeriyektha ezisebenza ehlabathini jikelele sithethanje. Ngenxa yoko, le teknoloji iyaziwa kwaye iyaqondwa, nto leyo enegalelo ekuthembekeni nakukhuseleko lwayo. IKoeberg yakhiwa ngo-1976 kwaye ineeyunithi zeriyektha ezimbini ezivelisa umbane ongange-930 MWe, enika uxinzelelo lwamanzi eriyektha [pressurised water reactor (PWR)]. Iteknoloji yePWR esetyenziswa eKoeberg yayisekelwe kuyilo lwaseWestinghouse yaza yakhiwa nguFramatome. Umfanekiso 5 ubonisa ukuveliswa kombane kusetyenziswa uyilo lwePWR.



Umfanekiso 5: Umzobo olula weriyektha yamanzi axinzelelweyo yesitishi senyukliya [21]



Umfanekiso 6: Uqwalaselo lwenkqubo yoyilo lwesitishi sePWR [22

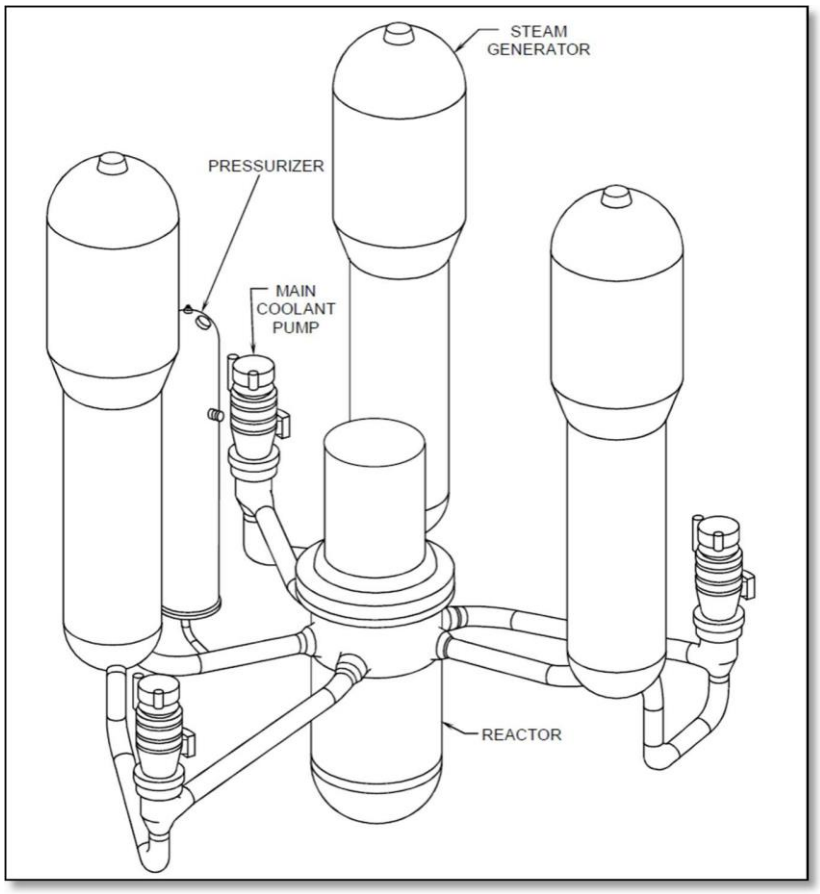
Iyunithi evelisa umbane yePWR yakhiwe yisistimu enamacandelo amathathu (eliyintloko, elesibini, neliphezulu), apho iisistimu zahluliweyo enye kwenye, njengoko kuboniswe Umfanekiso 6, kwaye mancinane amanzi apholiswayo adibanayo eesistimu ezimeleneyo. Olulwahlulo lweesistimu luvalela i-radioactivity ekwisistimu eyintloko nto leyo engumqobo othintela ukuphuma kwamanzi amdaka aneradiyeyishini.

Iyunithi yeriyektha nganye inesiqithi senyukliya (nuclear island), isiqithi seturbine (turbine island), umbhobho ongenisa amanzi nowakhuphayo. Iinxalenye eziphambili ze-nuclear island zezi:

- Isakhiwo seriyektha, esikwabizwa ngokuthi yi-containment. Sineriyektha nawo onke amacandelo amanzi apholisayo axinzelelweyo, iikhomponenti neenkqubo ezifunekayo ukuze iriyektha isebenze ngendlela ekhuselekileyo. Sisakhiwo esingcityiweyo, esibamba uxinzelelo esigcina kokubini iradiyeyishini ekhutshwa sisiqu seriyektha xa kungenzeka ingozi nesikhusela inkqubo kwiziganeko ezenzeka ngaphandle ezifana nemozulu embi nkqu nemijukujelwa yeebhombu. Sakhiwe ngekhonkrithi edeki kakhulu, neqiniswe ngentsimbi. Xa kusetyenzwa ngokuqhelekileyo isakhiwo seriyektha sihlala sikuxinzelelo oluphantsi. Inkqubo eyintloko ineenjini ezintathu zomphunga, iimpompo ezintathu zamanzi apholisa iriyektha, i-pressuriser, ne-reactor pressure vessel, ebamba amafutha enyukliya. Indlela emi ngayo isistimu eyintloko iboniswe kuUmfanekiso 7.

- Isakhiwo samafutha sihlala izakhiwo zokugcina amafutha amatsha xa engekafakwa kwiriyektha namafutha asetyenzisiweyo aphuma kwiriyektha. Isakhiwo samafutha sikwaqulethe izixhobo zedama lokupholisa amafutha nesistimu yokuhluza kunye nesistimu yongxamiseko yokufaka amanzi kwinjini yomphunga.
- Isakhiwo sokuncedisa inyukliya sinamagumbi anezixhobo zokuncedisa ukwenza umbane, aqulathe zonke iindlela zokulawula iyunithi (igumbi lokulawula nezakhiwo zokusebenza, umbane, nenkqubo yezixhobo neyokulawula).
- Isakhiwo senyukliya esincedisayo sihlala iinkqubo ezincedisayo ezifunekayo xa iriyektha isebenza ngokuqhelekileyo kwaye sixhasa iinkqubo zokhuseleko. Esi sakhiwo sihlala izixhobo zokusebenza nenkqubo yokulawula iikhemikhali nobungakanani bezinto, inkqubo yokusebenza inkcitho eyirhasi, inkqubo yokusebenza amanzi apholisayo alahlwayo, nenkqubo yokusebenzisa ngokutsha i-boron.
- Ngokobume bezakhiwo ezibini ezahlukeneyo, isakhiwo ngasinye sihlala injini yedizili (umbane wemeko yongxamiseko).

Iyonke i-nuclear island ixhonywe kwinkqubo enciphisa intshukumo xa kunyikima umhlaba. Le nkqubo ikhusela isakhiwo sesiqithi senyukliya kwiintshukumo kuvumela iyunithi yriyektha ukuba icinywe ngendlela ekhuselekileyo.

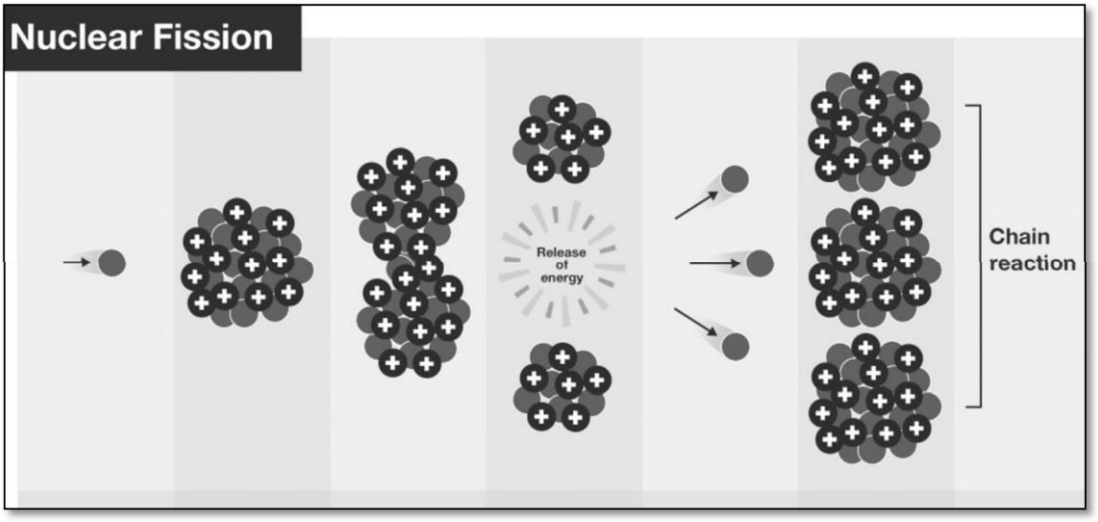


Umfanekiso 7: Umzobo wokuma kwee-SSC kwisitishi senyukliya esinamacandelo amathathu [23]

9.2 Ukuveliswa kombane kwizitishi zokuphehla umbane zenyukliya

9.2.1. Ukuqhekeka kwenyukliya

IKoeberg ixhomekeka kwi-uranium etyetyiswe kancinci njengomthombo wamafutha avelisa ubushushu. Ubushushu obuveliswayo ebudeni bokuqhwitha kwenyukliya kudala inkqubo ebizwa ngokuthi 'kukuqhekeka' (fission). Ukuqhekeka kuquka ukwahlulwa kweeathomu zenyukliya ngamasuntswana, abizwa ngokuthi zii-neutrons. Xa iathomu yenyukliya enkulu zibethwa yineutron, iyahluka kwaye ziimveliso zoqhekeko ezimbini okanye ngakumbi ezincinane ize ivelise amandla nee-neutron xa isenjenjalo. Emva koku ii-neutron ezikhululweyo ziyaqhubeka ziqhekeka ibe ngumtyhutyhumezo woqhekezo lwenyukliya. Ukwahlulwa kweeathomu nokukhululwa kwamandla kubizwa ngokuba kukuqhekezwa kwenyukliya (Umfanekiso 8).



Umfanekiso 8: Intsabelo yokuqhekezwa kwenyukliya [24

Le nkqubo yokuqhekezwa ilawulwa ngobunono kusetyenziswa i-boric acid enyibilikiswe kumanzi enkqubo eyintloko (isipholisi seriyektha) nakwiicontrol rods zeriyektha ukuze kuqinisekiswe ukuba imida yoyilo akugqithwa kuyo.

Amanzi akwisistimu eyintloko wona aye ajikeleziswe kwisistimu eyintloko ukuze kuphume amandla obushushu avela kwiriyektha ukuze kugcinwe ubushushu bayo bukwiqondo elibekwe kuyilo. Amanzi atshisayo aphuma kwiriyektha ngomlenze otshisayo weriyektha angene kwinjini yomphunga. Kwinjini yomphunga amanzi esekethi eyintloko ayapholiswa njengoko edlulisela ubushushu bawo kwisekethi yesibini. Ukusuka kwinjini yomphunga, amanzi esekethi eyintloko ayampontshwa abuyiselwe kumlenze obandayo weriyektha ngeempompo zamanzi okupholisa iiriyektha apho eye aphinde afudunyezwe ngamandla akhutshwa yinkqubo yokuqhekezwa kwenyukliya. Iyunithi nganye yaseKoeberg inamacandelo esekethi ayintloko amathathu, oko kukuthi, iinjini zomphunga ezintathu kunye neempompo eziyintloko ezintathu. Elinye lamacandelo esekethi eyintloko linesixinzeleli esigcina uxinzelelo lwesistimu eyintloko luphezulu ngokwaneleyo ukuba luthintele amanzi akwisekethi eyintloko angabili, yiloo nto ibizwa ngokuthi yiriyektha yamanzi axinzelelweyo.

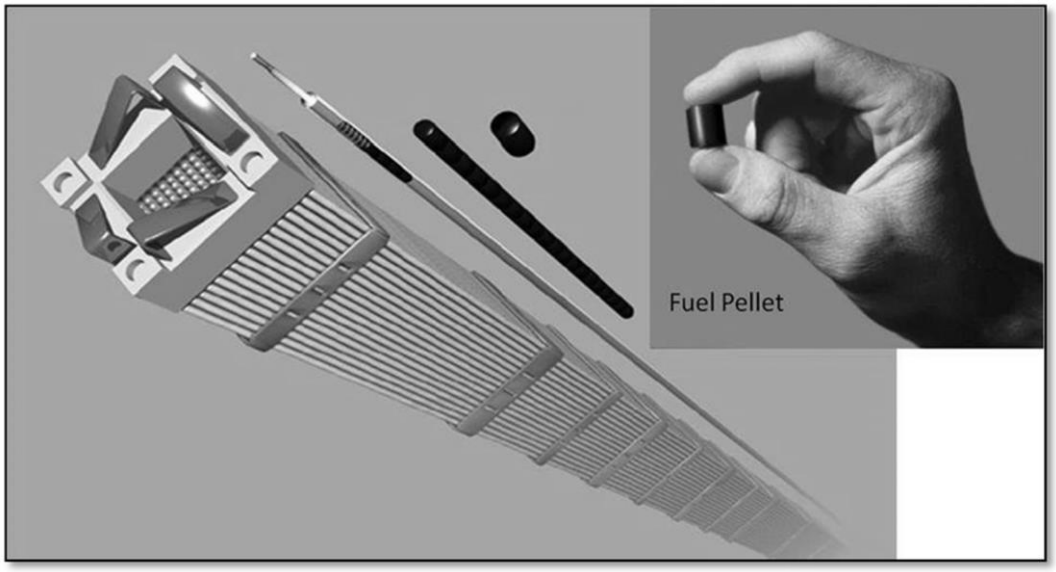
Kule nkqubo, ubushushu budluliselwa phakathi kwesistimu eyintloko neyesibini. Kwicala lesibini lenjini yomphunga, amanzi ayavunyelwa ukuba abile ukuze atshintshwe abe ngumphunga. Lo mphunga ke uye usetyenziswe ukuqhuba i-turbine ethi yona iiqhube injini evelisa umbane. Emva kokudlula kwiturbine, umphunga uyatshintsha ube ngamanzi ukuze uphinde ubuyiselwe kwiinjini zomphunga, ube uyayigqiba ke isekethi yesibini. Amanzi avela kuLwandle LweAtlantiki abandayo ampontshwa athubeleze kwikhondensa (condenser) ekwisekethi yesithathu, okanye ekwinqanaba elingentla, ibe ubushushu

obukhutshuweyo bubuyiselwa kuLwandlekazi LweAtlantiki. Ngoko iKoeberg isebenza ngeesekethi zamanzi

ezintathu ezahlukeneyo: eyintloko, eyesibini, neyenqanaba elingentla. Injongo yokwahlula ezi sistimu zintathu kukuqinisekisa ukuba amanzi avela kwisistimu eyintloko, ahlulwa ngokupheleleyo kwezinye iisistimu ukuze kuthintelwe ukudibana kwesistimu eyintloko yenqanaba elingentla, kuba isistimu yenqanaba elingentla iyadibana nokusingqongileyo.

9.2.2. Imathiriyali esetyenzisiweyo eneradiyeyishini

Iiriyektha zenyukliya zaseKoeberg zivelisa zize zilawule ukukhululwa kwamandla ngenkqubo yokuqhekeka kwenyukliya (okokukuthi ukwahlulwa kweeathomu) zisebenzisa ngakumbi ii-isotope ze-uranium-235 (U-235) ezikuhlobo lwe-pellet ze-uranium oxide (UO_2), njengamafutha. Ii-pellets ze-UO_2 zipakishwa kwiityhubhu ukuze ziyile ii-fuel rod, zize zona zifakwe kwisiqu seriyektha njengamalungu afaka amafutha, aboniswe kuMfanekiso 9. Kwisiqu seriyektha ii-isotope ze-U-235 ziyaqhekezwa okanye zahlulwe, kuveliswe ubushushu obuninzi kwinkqubo eqhubekayo ebizwa ngomtyhutyhumezo wokuqhekezwa kwenyukliya (chain reaction).



Umfanekiso 9: Umfanekiso we-fuel assembly yePWR eqhelekileyo, ne-fuel rod, i-control rod ne-pellet yamafutha eboniswe iyodwa

Kusetyenziswa amanzi njengesithomalalisi ukuze kuthotywe isantya see-neutron ezikhululwa yinkqubo yokuqhekeka kwenyukliya ukuze ziqhekeze inyukliya nangakumbi, noxa ii-control rod ne-boron enyibilikileyo kwisipholisi esiyintloko

zisetyenziswa ukufunxa ii- neutrons ukuze kulawulwe izinga lentsabelo kwisiqu seriyektha.

Ii-fuel rod zine-uranium, etyetyisiweyo kodwa ayadlula ku-4.95 % U-235, ekuhlobo lwee-pellets ezimile okwesilinda ze-uranium dioxide, ezikwiityhubhu zamafutha. Ezi tyhubhu zamafutha zenziwa nge-alloy ye-zirconium ngenxa yokuba ineempawu ezifunekayo, iyakwazi ukunyamezela ukukrweleka, kwaye ayizifunxi kakhulu iineutron. Ii-fuel rod

ziyaxinzelelwa ngaphakathi nge-helium ebudeni bokuyilwa kwazo ukuze kuthintelwe ukuba sicaba kwetyhubhu. Ezi tyhubhu ziba ngumqobo wokuqala wokuvalela iradiyeyishini ngaphakathi kwe-fuel rod. Ii-fuel rod zinganezifunxi ezitshayo ezizii-pellet zamafutha eziimile njenge-boride okanye ngee-pellet zamafutha e-uranium oxide axutywe ne-gadolinium oxide, okanye intlanganisela yazo, ukuze kulawulwe intsabelo kwisiqu seriyektha.

Iimveliso zokuqhekezwa kwenyukliya neziyilelo ezinzima ziza kwanda njengoko kusetyenzwa, ukusa kwinqanaba lokuba kungakwazeki ukuqhubeka kusetyenziswa loo mafutha. Xa ekhutshiwe kwiriyektha, amafutha asetyenzisiweyo aza kuqhubeka ekhupha iradiyeyishini nobushushu. Imijikelo yokucima iiyunithi ukuze kutshintshwe amafutha idla ngokuba phakathi kweenyanga eziyi-12 neziyi-24. Xa icinyiwe iyunithi ukuze kutshintshwe amafutha, isinye kwisithathu samalungu agcina amafutha kuphela esitshintshwayo, ngamanye amazwi, isibini kwisithathu samafutha asetyenzisiweyo siphinda sibuyiselwe kunye nesinye kwisithathu samafutha amatsha.

Ukusuka kwisiqu seriyektha, amalungu amafutha asetyenzisiweyo abekwa kwidama lamafutha asetyenzisiweyo ukuze ubushushu neradiyeyishini zehlele kumaqondo amkelekileyo ngaphambi kokuba asiwe kwimigqomo yamafutha asetyenzisiweyo. Kwidama lamafutha asetyenzisiweyo, amanzi ayakhusela kwiradiyeyishini kwaye afunxa ubushushu obukhutshwa ngala mafutha. Amalungu afaka amafutha asetyenzisiweyo agcinwa kumadama amafutha asetyenzisiweyo iminyaka eqikelelwa kweyi-10 ukuze aphole kwaye kuxhomekeka ekufumanekeni kwesikhewu kwidama lamafutha asetyenzisiweyo.

10. IMINGCIPHEKO KUKHUSELEKO, IMPILO, NOKUSINGQONGILEYO EDIBENE NOKUSETYENZISWA KWESITISHI IXESHA ELONGEZELELWEYO

IKoeberg oko yaqhubeka isebenza ngokukhuselekileyo ukususela ekugunyazisweni kokusebenza kwayo ngo1984. Oku kube yimpumelelo ngenxa yoyilo lwesi sitishi olungqongqo, ukusetyenziswa kweenkqubo zokhuseleko ezingqingqwa (umzekelo, ukulondoza izixhobo zokukwenza umbane), ukuthotyelwa kweenkqubo (umzekelo, ukuqinisekiswa komgangatho), nokwabelana ngolwazi nemibutho yamazwe ngamazwe anxulumene nezombane owenziwa ngenukliya, enjengoWANO neIAEA. I-NNR

ikwanendima ebalulekileyo ekuqinisekiseni ukuba iKoeberg iyaqhubeka isebenza ngokukhuselekileyo, ngokongamela ngqongqo ngemiyalelo eyibekayo.

10.1 Imingcipheko yokhuseleko lwenyukliya

Imingcipheko yeengozi zenyukliya ezinokubangela ukuba kuphume iradiyeyishini ingene kokusingqongileyo, nomngcipheko kuluntu ngenxa yokusebenza ngendlela eqhelekileyo uphantsi kakhulu. Eli candelo lithetha ngemida yokhuseleko lwenyukliya ebekwe yiNNR, ingcamango yokuba amanqanaba ngamanqanaba obunzulu okhuselo (defence in depth [DiD]) esetyenziswa eKoeberg ukugcina imingcipheko ikwinqanaba elamkelekileyo, nolawulo lwengozi.

10.1.1. Imida yomngcipheko kukhuseleko lwenyukliya

I-NNR ichaza imiqathango engundoqo yokhuseleko (imida yomngcipheko) ekumele iKoeberg iyithobele [5]. Imiqathango engundoqo yokhuseleko yimida yomngcipheko wonyaka kuluntu nakubasebenzi ngenxa yokuchanabeka kwizinto ezineradiyeyishini ezibangelwa ziimeko eziqhelekileyo okanye yingozi eKoeberg. Uhlolo lokhuseleko kwinto enokwenzeka (PSA) yindlela elandela inkqubo ethile yokufumana nokuhlalutya imingcipheko engakho kuyilo nakumsebenzi ukuze kuziwe nezisombululo zokunciphisa ifuthe kwisitishi, kubemi nakokusingqongileyo. I-PSR ihlole iPSA ekhoyo ngoku yaza yangqina ukuba iKoeberg iyayithobela imiqathango engundoqo yokhuseleko nokuba eKoeberg kusetyenziswa inkqubo esebenzayo yokulawula umngcipheko ukuze kuqinisekiswe ukuba indlela yokusebenza ayiceli mngeni kwimiqathango engundoqo yokhuseleko.

Umngcipheko ophezulu wonyaka kwilungu ngalinye loluntu nakubasebenzi phantsi kweemeko zengozi eKoeberg ezinokukhupha iradiyeyishini awuvumelekanga ukuba udlule kumda oyi5x10^{-6} yabantu abaswelekayo ngonyaka, kunye ne-5 x 10^{-5} yabantu abaswelekayo ngonyaka, ngokulandelelanayo.

I-PSR ibonise ukuba iKoeberg iyayiithobela imiqathango engundoqo yokhuseleko kwaye igcine incopho yomngcipheko kawonke-wonke ungaphantsi nge-3% kumda weNNR omalunga ne- 1,17 x 10^{-7} yabaswelekayo ngonyaka, kwaye igcine nencopho yomngcipheko kubasebenzi ngaphakathi kwesiza seKoeberg ingaphantsi nge-20% yomda weNNR emalunga ne-7,56 x 10^{-6} yabasebenzi abaswelekayo ngonyaka.

Ukuze iqondakale kakuhle le ngcamango, mhlawumbi ungacinga ngomngcipheko wokusweleka kwingozi yemoto (njengomqhubi, umkhweli, okanye umntu ohamba ngeenyawo) eMzantsi Afrika. Ingxelo yonyaka yokhuseleko ezindleleni yango 2022 ithe bayi-12 436 abantu ababulewe ziingozi zeemoto ngo-2022 [33]. Ngokusekelwe kubemi base

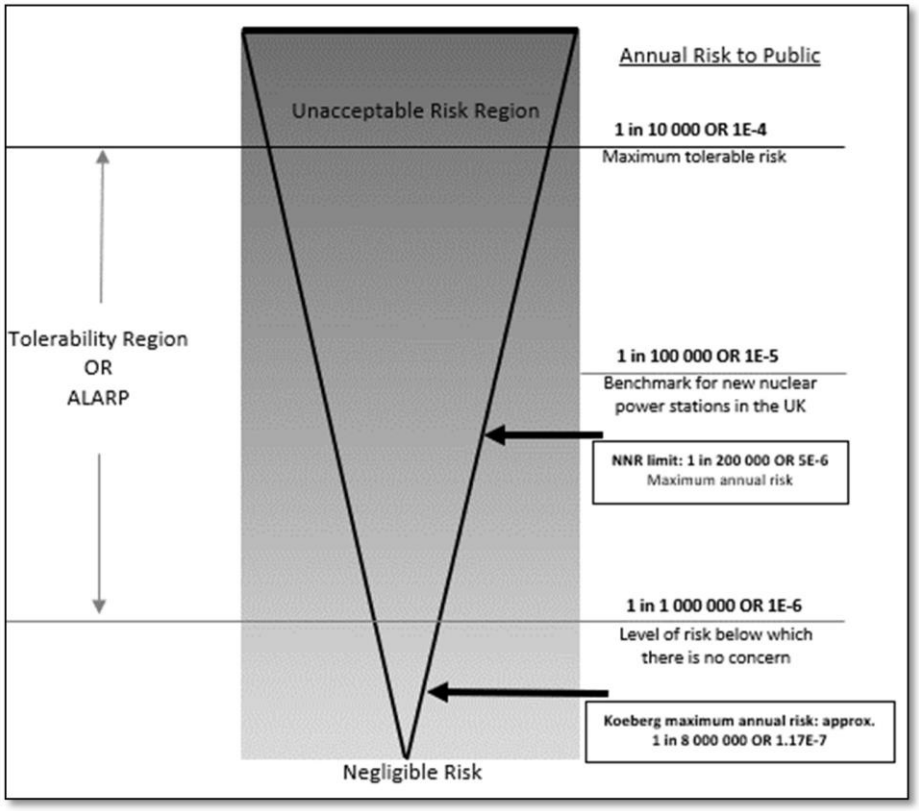
Mzantsi Afrika abazizigidi ezingamashumi amathandathu (60 million), umlinganiselo ophakathi womngcipheko kukuba abantu abayi-21, kwi-100 000 nganye yabemi (okanye 2,1 x 10^{-4} ngonyaka) kungenzeka babulawe yingozi yemoto eMzantsi Afrika nyaka ngamnye. Loo nto ithetha ukuba ilungu loluntu linamathuba angaphezulu kwe-1 000 okubulawa yingozi yemoto kunawokubulawa yingozi yenyukliya eKoeberg.

Akukho nantonina eyenziwa ngabantu, ingakumbi indlela yokuphehla umbane engenamingcipheko. Ngokutsho kwesigqeba esilawula ukhuseleko lwenyukliya e-UK, ingundoqo into yokuba imingcipheko ebekwa sisitishi senyukliya ibonakale iphantsi kangangoko kunokwenzeka (As Low As Reasonably Practical [ALARP]) njengoko kuboniswe kuMfanekiso 10, kucingwa ngemigaqo efunwa luqoqosho nokhuseleko. Ingcamango yeALARP ibufana neyeALARA, esisinyanzelo seNNR. Umngcipheko ophezulu kulo naliphi ilungu loluntu ovela kwisitishi esitsha senyukliya awufanelanga ugqithe ku-1 x 10^{-5} yabaswelekayo ngonyaka [6].

Umngcipheko waseKoeberg ungaphantsi (ukhuselekile) kunalo kwaye ukummandla owamkelekileyo kumzobo we-ALARP okuMfanekiso 10.

Masiyitsho ke into yokuba nakuba imiqathango engundoqo yokhuseleko ibekiwe yiNNR, akunakufane kwenzeke ukuba nabanina achaphazeleke empilweni okanye asweleke ngenxa yokongeza ixesha lokusebenza kweKoeberg ngeminyaka eyi-20. Akuzange kwenzeke ngozi yenyukliya ukususela oko iKoeberg yaqala ukusebenza. Akukho mngcipheko ungafanelekanga kumalungu oluntu okanye kubasebenzi ngenxa yokusebenza kweKoeberg.

IKoeberg iza kuqhubeka ithobela imiqathango engundoqo yokhuseleko ebudeni bexesha leLTO.



Umfanekiso 10: Ukulawula umngcipheko ube phantsi kangangoko kunokwenzeka (ALARP) kuthathwa [6]

10.1.2. Amanqanaba ngamanqanaba obunzulu okhuseleko (Defence in depth) kwizitishi eziphehla umbane ngamandla eNyukliya

I-USNRC ichaza “amanqanaba ngamanqanaba obunzulu okhuseleko (Defence in depth [DiD])” njengendlela yokuyila nokusebenzisa isitishi senyukliya ethintela nenciphisa iingozi ezikhupha iradiyeyishini. Ingcamango yeDiD isetyenziswa kakhulu kwizitishi zenyukliya ukuze kugcinwe umngcipheko wengozi ukumanqanaba amkelekileyo. Umphumela wokusebenzisa le ndlela yeDiD kukuba kubekho amanqanaba aliqela naphinda phindeneyo okukhuseleko (ekwabizwa ngokuba ngamalungiselelo) ukuze kulungiselelwe ukusilela kwabantu noomatshini. Ayikho into enye enokuthi yakusilela eKoeberg yenze kubekho ingozi, akukhathaliseki nokuba ibaluleke kangakanani loo khomponenti ekuqinisekiseni ukuba isitishi esenza umbane nge nyukliya sikhuselekile.

Ukuba kungenzeka kubekho ukusilela kwekhomponenti ebalulekileyo kukhuseleko, esisitishi sixhotyisiwe ukuze loo ngxaki ibonakale kwangoko khonukuze abaqhubi besisitishi balandele amaxwebhu abo baqinisekise ukuba ingozi iyathintelwa.

Itheyibhile 3: Amanqanaba ngamanqanaba obunzulu okhuseleko (Defence in depth [DiD]) [25]

Inqanaba le-DiD	Injongo	Iindlela ezibalulekileyo
Inqanaba 1	Ukuthintela ukusebenza ngendlela engafunekiyo nokusilela	Uyilo olungqingqwa nomgangatho ophezulu wokwakha nokusebenza
Inqanaba 2	Ukulawulwa kokusebenza ngendlela engafunekiyo nokubhaqwa kokusilela	Ukulawula, ukusikela umda, nobuxhakaxhaka boomatshini bokukhusela nezinye iinkqubo zokubeka esweni kobubuxhakaxhaka boomatshini
Inqanaba 3	Ukulawula iingozi ngokwesiseko soyilo	Iimpawu zokhuseleko zobunjineli nolawulo lwengozi
Inqanaba 4	Ulawulo lweemeko eziqatha zesitishi, kuquka ukuthintelwa kokuqhubekeka kwengozi nokunciphisa imiphumela yeengozi ezinkulu	Amanyathelo ancedisayo nokulawulwa kwengozi
Inqanaba 5	Ukuncitshiswa kwemiphumela yeradiyeyishini engamandla xa kungakho ingozi	Intsabelo yemeko yongxamiseko ngaphandle kwesiza saseKoeberg

I-PSR iwahlole omahlanu la manqanaba eDiD yaseKoeberg. Injongo yohlalutyo ibikukuqonda ukuba anele, amkelekile, kwaye angqingqwa na amalungiselelo eDiDeKoeberg. Amanqanaba amahlanu eDiD achazwa ngokubanzi kwi-IAEA INSAG-10 [25] kwaye aboniswa kwiTheyibhuli

3. Iye yaqinisekiswa into yokuba iKoeberg inamalungiselelo aneleyo okuqinisekisa ukuba amanqanaba eDiD asebenza ngokwanelisekileyo ngoku, kwaye xa eqhubeka elondolozwa futhi ephuculwa, ayakuhlala esebenza ebudeni beLTO. Ukuphuculwa kwemiqathango yangoku yokhuselo olunzulu kucwangcisiwe njengenxalenye yeziphumo ezivela kwiPSR.

10.1.3. Ulawulo lwengozi

Ulawulo lwengozi yinxalenye ebalulekileyo yamanqanaba ngamanqanaba obunzulu okhuseleko (DiD). Luquka iinkqubo ezilandelwayo nezicwangciso ezifunekayo ukuze kubuyiselwe isitishi kwimeko yokukhuseleka kwaye kuthintelwe okanye kuncitshiswe umngcipheko wokukhupha iradiyeyishini iye kokusingqongileyo. IKoeberg inamaxwebhu apheleleyo eenkqubo ezinokulandelwa xakunokuba khona ingozi, ikwanazo nezikhokelo zokulawula ingozi enkulu enokuthi yenzeke ingalindelekanga. La

maxwebhu ngawokusetyenziswa ukuze kunqandwe umonakalo kumafutha enyukliya kwaye kuthintelwe okanye kuncitshiswe ukuphuma kweradiyeyishini enokuchaphazela okusingqongileyo.

Ngokuhambisana nemigangatho yelizwe neyamazwe ngamazwe, iKoeberg inemigaqo ebekiweyo yokhuseleko eliqela yokulawula iimeko ezingaqhelekanga kunye nezengozi yenyukliya, ukuqinesekisa ukuba akukho mngcipheko ungafanelekanga eluntwini jikelele. Ezi meko zingaqhelekanga nezengozi yenyukliye zibizwa ngokuba ziingozi ezisekelwe kuyilo lwesitishi kuba ngenxa yoyilo lwesitishi, isitishi singakwazi ukumelana neziziganeko ngaphandle kokudlula kwimida egunyazisiweyo. Umzekelo, uyilo lweKoeberg lwenziwe ngohlobo lokuba ikwazi ukumelana nenyikima, embindi wayo ukwindawo enesiphako, kwiikhilomitha eziyi-8 ukusuka eKoeberg, enesilinganiso esingu-7 ngokwesikali sikaRichter (oko kukuthi, inyikima enkulu). Ingakwazi nokumelana netsunami enamaza aziimitha eziyi-8 ukuphakama.

EFukushima, iimeko neziganeko zazinzima kakhulu kunoko kwakulindelwe kuyilo lwesitishi yaza loo nto yadala ingozi enkulu kunaleyo uyilo lwesitishi lusekelwe kuyo. Umzekelo, itsunami yayingaphaya kodonga olungumqobo oluziimitha eziyi-5,5 ukuphakama yaze yabangela izantyalantyala zamanzi kwiinjini zedizili zemeko yongxamiseko kwiiyunithi ezintlanu kwezintandathu zeriyektha yenyukliya[10]. Njengokuba inyikima yatshabalalisa iintambo ezihambisa umbane ukusuka kwisitishi esiwuphehlayo ukuya kubasebenzisi bombane (network grid [igridi]), iFukushuma yaphela ingenawo umbane (okanye umbane ogcinelwe ukusekela kwimeko kaxakeka) wokusetyenziswa kubuxhakaxhaka boomatshini bokhuseleko kwiiyunithi zeriyektha yenyukliya ezintlanu.

Esi siganeko saseFukushima sibonise ukuba kungenzeka kubekho iimeko eziqatha ngakumbi kunezo zisekelwe kulo uyilo lweengozi zesitishi, nangona amathuba okuba zenzeke emancinci kakhulu. Ezi zaziwa ngokuba ziimeko ezigqithela ngaphaya kuyilo lwesitishi.

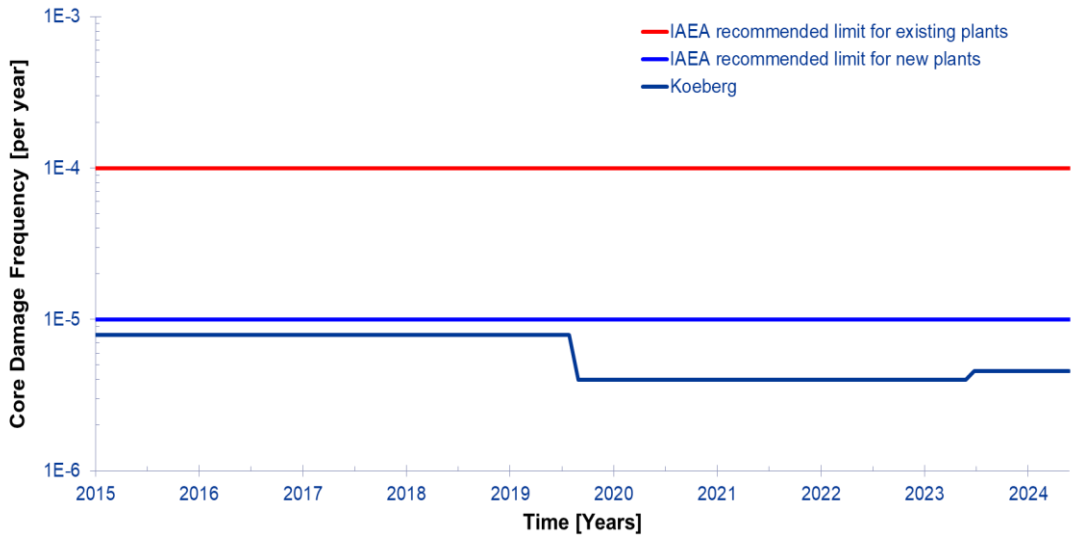
IKoeberg yenze utshintsho kwikhomponenti eziliqela ukuze isebenzise izifundo ezifunde eFukushima, kwaye amanye amanyathelo okuphucula ukhuseleko aqukwe kwisicwangciso sokuphucula esidityanisiweyo sePSR. Imizekelo yezinto ezitshintshiweyo eKoeberg ezenzelwa iimeko ezigqithela ngaphaya koyilo lwesitishi kukongeza iinjini zedizili eziphathekayo, iimpompo eziphathekayo ukuze kubekho omnye umthombo wamanzi okupholisa amadama amafutha asetyenzisiweyo, izixhobo eziphathekayo zokukhupha ingqushu ebangelwe yinyikima enkulu, neezixhobo zokunciphisa ihydrogen kwisakhiwo sokugquma iriyekta (autocatalytic recombiner) ukuze kuncitshiswe uqhushumbo lwe-hydrogen. Ukongezelela koko, izikhokelo zokulawula

ingozi enkulu zaseKoeberg zinamalungiselelo okusebenzisa iinjini zedizili zokusekela eziphathekayo zemeko yongxamiseko ukwenzela xa kunokuthi ungasebenzi umthombo

wombane oyintloko ovela kwigridi yelizwe nakwii njini zedizili zokusekela zemeko kaxakeka. Kucetywa umsebenzi ongakumbi njengamalinge okuqhubeka kuphuculwa kwaye kuncitshiswa nangakumbi umngcipheko weengozi eziqatha, osele uyingxenye yemida yolawulo yomngcipheko ebekiweyo (jonga uMfanekiso 11).

Njengoko kuchaziwe kwicandelo 10.1, iziphumo zePSR zibonise ukuba iKoeberg iyayithobela imiqathango engundoqo yokhuseleko echazwe kwi-RD-0024 [5]. Umngcipheko wokonakala kwamafutha enyukliya kwiriyektha ngenxa yengozi yenyukliya eKoeberg uye waphucuka ebudeni bexesha njengoko bekuphunyezwa uphuculo lokhuseleko olubonakala ngokuncipha kwamatyeli okonakala kwikhomponenti ekufakwa kuyo amafutha enyukliya xakusenziwa umbane (riyektha core) kuMfanekiso 11 ngexesha elisusela ku 2015 ukuya ku 2024. Amatyeli okonakala kwe riyektha core ichazwa njengamathuba okuba ingozi ibangele ukuba amafutha enyukliya akwiriyektha onakale kwaye ngoku angaphantsi kwe-1E-5 (1 x 10-5 ngonyaka) eKoeberg.

Ngelishwankathelayo, amathuba okuba konakale amafutha enyukliya kwiriyektha eKoeberg ngoku aphantsi kakhulu kwaye ayathelekiseka ngokuyeleneyo nawezitishi zombane wenyukliya ezintsha [6]. Loo nto ibangelwe kukuqhubeka kusenziwa uphuculo kukhuseleko. Umngcipheko waseKoeberg kulindeleke ukuba uhlale ungagqithanga kwimiqathango engundoqo yokhuseleko ebudeni beLTO.



Umfanekiso 11: Amatyeli okonakala kwesiqu ngonyaka

Ifuthe leradiyeyishini kwimpilo yabantu kuthethwa ngalo kweli candelo. Eli candelo liza kubonisa ukuba akukho mngcipheko ungafanelekanga kwimpilo yoluntu ngenxa yokusebenza ngendlela ekhuselekileyo eminye iminyaka eyi-20 kuba amanzi alahlwayo angcoliswe yiradiyeyishini ebudeni beLTO kulindeleke ukuba ahlale engaphantsi kakhulu kwimida yemiyalelo ebekiweyo (jonga icandelo 10.2.3). Ubungakanani be

radiyeyishini efunyanwa ngabasebenzi (Occupational dose [Idowusi]) yasemsebenzini inganda kancinci ngenxa yokwanda komsebenzi odibene neLTO (umzekelo, ukutshintshwa kweenjini zokwenza umphunga nokutshintshwa kwe-ntloko yomphanda weriyektha (reactor vessel head); kodwa ke, ekubeni amanqanaba edowusi akhoyo emsebenzini ngoku engaphantsi kakhulu kwimida ebekwa yimiyalelo, akulindelekanga ukuba kugqithwe kwimida yedowusi ebekelwe abasebenzi ebudeni beLTO. (Jonga i candelo 10.2.4 necandelo 11.5).

10.1.4. Iradiyeyishini kubomi bemihla ngemihla

Lo mbhalo ulandelayo uthathwe kwiphepha leIAEA lezibakala ngeradiyeyishini [9]:

Iimathiriyali ezineradiyeyishini yendalo zikho kumphezulu womhlaba, kwimigangatho neendonga emakhayeni ethu, ezikolweni, naseziofisini, nasekutyeni esikutyayo nakwiziphuzo esiziselayo. Kukho iirhasi ezineradiyeyishini kumoya esiwuphefumlayo. Imizimba yethu – izihlunu, amathambo, nezihlunwana – ziqulathe iimathiriyali ezineradiyeyishini ebakho ngokwendalo.

Sichanabeke nakwiradiyeyishini eyenziwe ngabantu (njengeEksreyi), iradiyeyishini esetyenziswa ukuxilonga izifo nonyango lomhlaza. Iziphumo zokuvavanya iziqhushumbisi zenyukliya, neemathiriyali ezincinci ezineradiyeyishini ezingena kokusingqongileyo zivela kwizitishi eziphehla umbane ngamalahla nangenyukliya, nazo ziyimithombo yokuchanabeka kwabantu kwiradiyeyishini.

I-radioactivity ligama elisetyenziswa ukuchaza ukuqhekeka kweeathomu (atoms). Iathomu ingachazwa ngokwenani lee-protons (positively charged) kwinyukliyasi yayo. Ezinye izinto zendalo azizinzanga. Ngoko ke, inyukleya yazo iyaqhekeka okanye iphelelwe ngamandla emva kwexesha, ngaloo ndlela ikhuphe amandla ayiradiyeyishini. ESi senzeko sendaloo sibizwa ngokuba yi-radioactivity. Ukuphelelwa ngamandla kwe nyukleyi okubangela iradioactivity kulinganiselwa ngokweeyunithi ezibizwa ngokuba zii-becquerels. I-becquerel enye ilingana noqhekeko olunye ngomzuzwana.

Ixesha elithathayo ukuze isiqingatha see-radionuclides ziqhekeke okanye ziphelelwe ngamandla libizwa ngokuba sisiqingatha sobomi. Le nto iyahluka kwi-radioelement nganye, ukusuka kwinxalenye yomzuzwana ukuya kwiibhiliyoni zeminyaka. Umzekelo, isiqingatha sobomi be-iodine-131 ziintsuku ezisibhozo, kodwa kwi-uranium-238, ekhoyo ngamanani ahlukeneyo ehlabathini jikelele, yiminyaka eyi-4,5 yamawaka ezigidi (bhiliyoni). I-Potassium-40, engumthombo oyintloko we-radioactivity emizimbeni yethu, inesiqingatha sobomi esiyi- 1,42 yeebhiliyoni zeminyaka.

Igama elithi "radiyeyishini" libanzi kakhulu kwaye liquka izinto ezifana nokukhanya kunye namaza kanomathotholo. Kwimeko yethu, ibhekisela kwiradiyeyishini "efaka i-

ion", nto leyo ethetha ukuba ngenxa yokudlula kwalo radiyeyishini entweni, ingayibangela ukuba ibenombane okanye ibe ne-ion. Kwiizihlunwana zomzimba eziphilayo, ii-ion zombane eziveliswa yiradiyeyishini zingachaphazela iinkqubo eziqhelekileyo zebhayoloji. Iiradiyeyishini eziqhelekileyo ezifaka i-ion ekudla ngokuthethwa ngazo zezi:

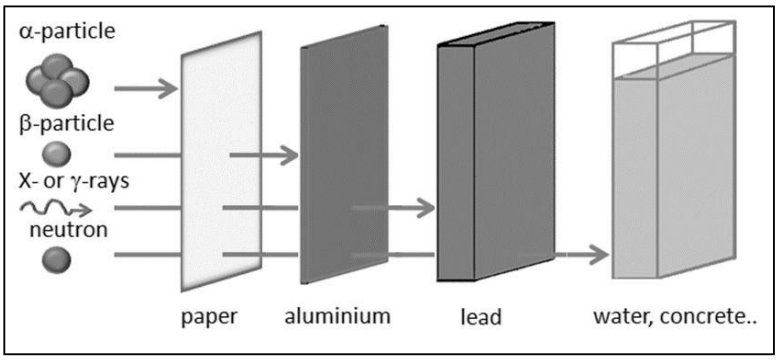
Iradiyeyishini ye-alpha inamasuntsu anzima, atshajiweyo akhutshwa ziiathomu zezinto ezifana ne-uranium ne-radium. Iradiyeyishini ye-alpha ingapheliswa ngokupheleleyo liphepha okanye yinwebu egubungele ulusu lwethu (iepidermis). Kodwa ke, iimathiriyali ezikhupha i- alpha zingena emzimbeni naxa siphefumla, sisitya, okanye sisela, zichanaba izihlunwana ezingaphakathi ngokungqalileyo kwaye, ngenxa yoko, zingakwazi ukudala umonakalo emzimbeni.

Iradiyeyishini ye-beta inee-electrons (negatively charged). Zingena ngamandla kunamasuntswana e-alpha kwaye ziyakwazi ukugqitha kwisentimitha e-1 ukuya kwezi-2 zamanzi. Ngokuqhelekileyo, icangci le-aluminium elinobudeki beemilimitha ezimbalwa liyayinqanda iradiyeyishini ye-beta.

Imitha ye-gamma yiradiyeyishini ye-electromagnetic efana neEksreyi, ukukhanya, namaza kanomathotholo. Imitha ye-gamma, kuxhomekeka kumandla ayo, ingatyhubela ngaphaya komzimba womntu, kodwa inqandwe ziindonga ezideki zekhonkrithi okanye ilothe.

Ii-neutrons ngamasuntswana angatshajwanga kwaye azivelisi i-ion ngokungqalileyo, kodwa xa zidibana neeathomu zezinto zingadala i-alpha, i-beta, i-gamma, okanye iiEksreyi, ethi yona idale i-ion. Ii-neutrons ziyakwazi ukutyhubela ezintweni kwaye zinganqandwa kuphela yikhonkrithi engqindilili, ngamanzi, okanye yiparafini.

Ukuze kuncitshiswe ubungozi beradiyeyishini, kusetyenziswa izixhobo ezahlukeneyo zokugquma ukuze kukhuselwe uwonke-wonke ekuchanabekeni ngokungeyomfuneko kwiradiyeyishini, njengoko kuboniswe kuMfanekiso 12. Nangona singenakuyibona okanye siyive iradiyeyishini, ingabonwa ize ilinganiselwe nkqu nentwana yayo ngezixhobo zokuyilinganisa ezilula kakhulu



Umfanekiso 12: Iintlobo zeradiyeyishini efaka i-ion kunye nezinto zokukhusela kuzo

10.1.5. Idowusi yeradiyeyishini neengozi emzimbeni ezibangelwa kukuchanabeka kwiradiyeyishini

Idowusi yeradiyeyishini abachanabeka kuyo abasebenzi noluntu ngenxa yomsebenzi owenziwa eKoeberg iphantsi kakhulu kunedowusi ekulindelwe ukuba idale umonakalo.

Idowusi efunxiweyo ngamandla afakwe yiradiyeyishini kwizihlunwanana zomzimba ilinganiswa nge-gray (Gy). Iziphumo ezibakho emzimbeni ngenxa yokungena kwe-ion ziyahluka ngokohlobo namandla. Isilinganiso somngcipheko womonakalo emzimbeni silingana nedowusi yeradiyeyishini efunyanwa seso sihlunwana somzimba. Iyunithi yedowusi yeradiyeyishini elinganayo yi-sievert (Sv). Ekubeni i-sievert enye inomlinganiselo omkhulu, iidowusi zeradiyeyishini ekudityanwa nazoo ngokuqhelekileyo zichazwa ngokwe-millisievert (mSv) okanye i-microsievert (µSv), ezisisinye kwiwaka nesinye kwisigidi se-sievert, ngokulandelelana. Iyunithi endadlana yedowusi yeradiyeyishini elinganayo yi-rem (i-roentgen equivalent man). Uguqulelo: 1 rem = 0,01 Sv; 1 Sv = 100 rem.

Umzekelo, iEksreyi enye yesifuba ikhupha malunga ne-0,1 mSv yedowusi yeeradiyeyishini, logama iskeni se-computer tomography (CT) somzimba wonke sichanaba umntu kwi-10 mSv [26]. Ngokomlinganiselo ophakathi, ukuchanabeka kwiradiyeyishini (exposure to radiation) ngenxa yayo yonke imithombo yendalo kuba malunga ne-2,4 mSv ngonyaka [9]; kodwa ke, eli nani lisenokungafani, kuxhomekeka kwindawo akuyo umntu, ngamakhulu aliqela eepesenti. (Umzekelo, eUnited States of America, iradiyeyishini evela kwindalo imalunga ne-3 mSv ngonyaka [26].)

Xa kubalwa idowusi yoqobo kuye kucingelwe zizonke iidowusi ezilinganayo kuzo zonke izihlunwana namalungu omzimba. Izihlunwanana namalungu omzimba angafaniyo ayahluka kwindlela asabela ngayo kwiradiyeyishini, ngoko idowusi yoqobo yidowusi efunyanwa nguwo wonke umzimba.

Iingozi ezidibene nokuchanabeka kwiradiyeyishini zixhomekeka kuhlobo lweradiyeyishini, ubude bexesha efakwa ngalo, nobungakanani bamandla wayo angena kwizihlunwana zomzimba. Xa amanqanaba okuchanabeka ephezulu ngokwaneleyo, iradiyeyishini efaka i- ion idala utshintsho kumalungwana, idale umonakalo kumalungwana, okanye yenze amalungwana afe kuze kulandele imiphumela emibi kakhulu kwimpilo (umzekelo, ukutsha kolusu nokukhula kwenwebu emehlweni (cataracts). Ezi zaziwa njengeziphumo eziqinisekileyo. Iziphumo eziqinisekileyo zidla ngokubakho kwidowusi eziphezulu. Azikho iziphumo eziqinisekileyo ezilindelekileyo xa umntu efumene ngaphantsi kwedowusi eyi-100 mGy ngaphezu kweradiyeyishini esichanabeka kuyo evela kwindalo [8].

Imiphumela engenakuqikelelwa yeradiyeyishini iquka umhlaza neziphene zemfuzo. Imiphumela engenakuqikelelwa iyalibaziseka ize ivele ngexesha elithile emva kokuba umntu echanabeke kwiradiyeyishini kwaye ngokuqhelekileyo emva kweminyaka emininzi. Iidowusi ezingaphaya kwe-100 mSv zinyusa umngcipheko womhlaza. Kodwa ke, xa iradiyeyishini iyidowusi ephantsi (ingaphantsi kwe-100 mSv [8]) kusekho ukungaqiniseki okukhulu ngemiphumela xa iyonke. Nangona sinolu lwazi luqokelelweyo ngemiphumela yeradiyeyishini, akukacaci ngokupheleleyo enoba ukuchanabeka kumanqanaba endalo eradiyeyishini kubeka impilo emngciphekweni nangayiphi na indlela.

Iindlela ezisisiseko zokukhusela kwiradiyeyishini zisetyenziswa ngendlela efanayo ehlabathini lonke. IKomishini Yamazwe Ngamazwe Yokhuseleko Kwiradiyeyishini (International Commission on Radiological Protection [ICRP]) nakuphi na ukuchanabeka komntu okudlula kwiradiyeyishini eveliswa yindalo kufanele kugcinwe kuphantsi kangangoko kunokwenzeka (as low as reasonably achievable [ALARA]), kodwa kube ngaphantsi kwemida yedowusi yomntu ngamnye. Umda wedowusi yomntu ngamnye kubasebenzi abasebenza ngeradiyeyishini ngokomlinganiselo ophakathi weminyaka emihlanu yi-100 mSv, yaye kuluntu jikelele yi-1 mSv ngonyaka (ungaphantsi kwedowusi yeradiyeyishini evela kwindalo).

Le mida yedowusi ziingcebiso ezisuka kwi-ICRP kwaye yamkelwe zizitishi eziphehla umbane wenyukliya. Ibekwe ngokusekelwe kwindlela yobulumko ngokucingela ukuba akukho dowusi isikelweyo ngezantsi kwayo ekungayi kubakho miphumo mibi kwimpilo yabantu. Loo nto ithetha ukuba nayiphi na idowusi eyongezwayo iza kudala ukwanda okukhulu kumathuba okuchaphazeleka kwempilo. Obu budlelwane akukaqinisekwa ngabo kwiidowusi eziphantsi (ngaphantsi kwe-100 mSv); kodwa ke, ukuze silumkele into esingayaziyo, nayiphi na idowusi igqalwa njengenokuyichaphazela impilo.

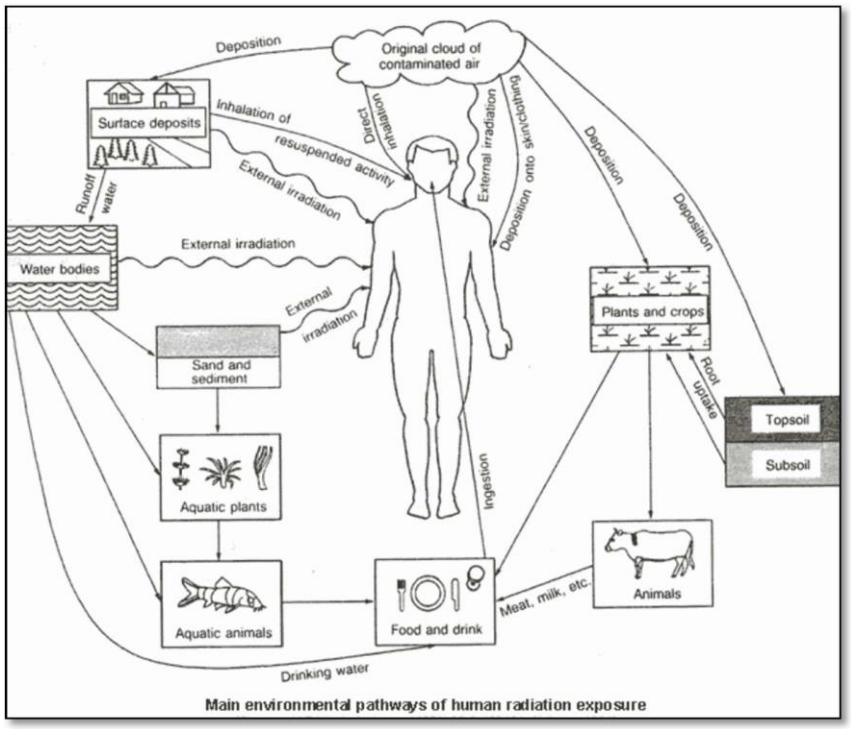
I-ICRP ikhuthaza imigaqo esisiseko ebalulekileyo emithathu kukhuseleko lweradiyeyishini: izizathu ezixhasayo; izinto ezintle ezifumanekayo ngokuchanabeka

kwiradiyeyishini zimele zibe ninzi kunezimbi; ukusebenzisa kangangoko: idowusi kufuneka igcinwe iphantsi kangangoko kunokwenzeka; kwaye nemida yedowusi: iyonke idowusi kuye nawuphi umntu kufuneka ihlale iphakathi kwemida.

Ngokubanzi, kube kunjalo nalapha eKoeberg, umlinganiselo ophakathi wedowusi yonyaka efunyanwa ngabantu abasebenza ngeradiyeyishini nanguwonke-wonke iphantsi kakhulu kunemida yedowusi yomntu ngamnye. Ngoko, akunakufane kwenzeke ukuba nabani na (kuluntu okanye kubasebenzi) achaphazeleke empilweni ngenxa yokuba kwandiswe ixesha lokusebenzisa iKoeberg ngeminyaka eyi 20.

10.1.6. Ifuthe leradiyeyishini kuluntu

Ukuchanabeka kungahlahlelwa ngokokwamanqanaba amathathu: ukuchanabeka emsebenzini (ukuchanabeka kwabasebenzi ngenxa yomsebenzi wabo), ukuchanabeka kwezamayeza (ukuchanabeka ngenxa yokuxilongwa okanye unyango), nokuchanabeka kukawonke-wonke (ukuchanabeka koluntu kwiradiyeyishini ngenxa yokuchanabeka kuzo zonke iintlobo zemithombo yeradiyeyishini, eyenziwe ngabantu okanye eyendalo).



Umfanekiso 13: Iindlela zokuchanabeka [28]

Ukuchanabeka ngeradiyeyishini kungakokwangaphakathi okanye okwangaphandle komzimba futhi kungafunyanwa ngeendlela ezahlukeneyo zokuchanabeka, umzekelo,

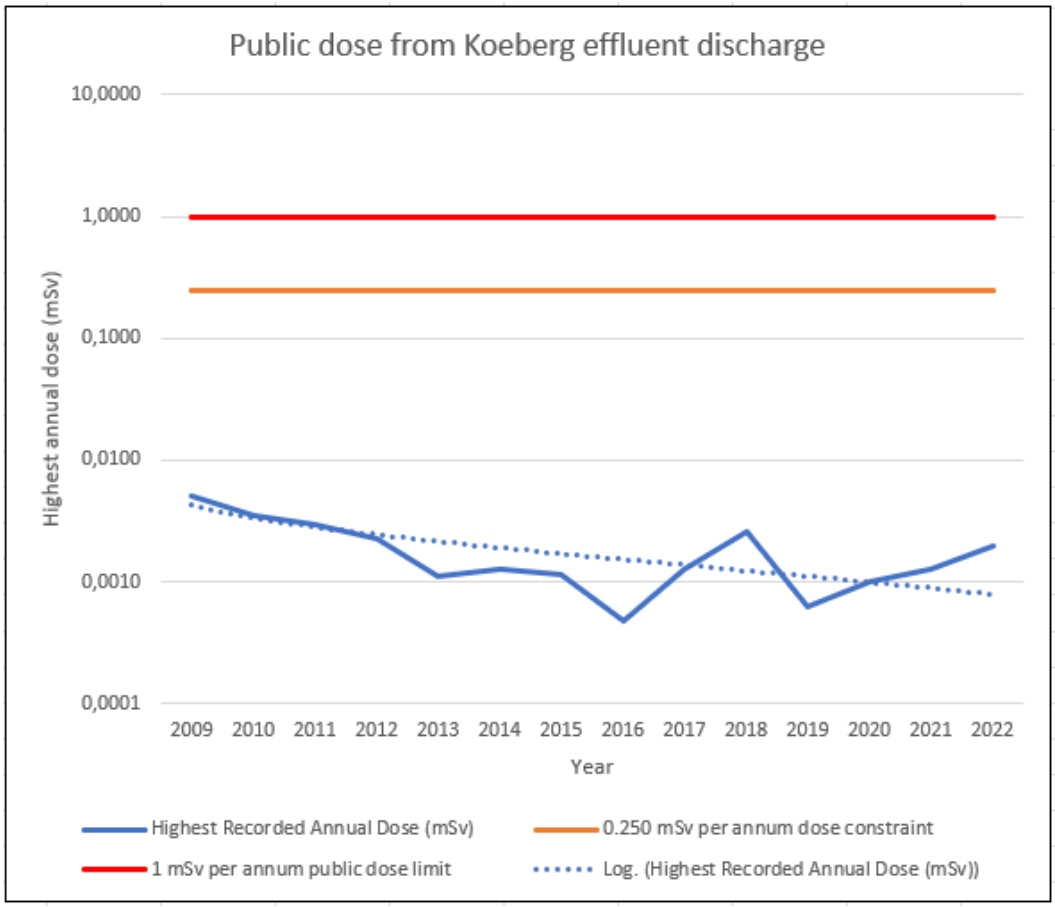
ngokusezela, ngokuginya, okanye ngokungqalileyo (jonga Umfanekiso 13). Ukuchanabeka ngaphakathi kwenzeka xa i-radionuclide isezelwe okanye iginyiwe, noxa ukuchanabeka kwangaphandle kungenzeka xa umntu echanabeke kwiradiyeyishini evela kumthombo ongaphandle njengeEksreyi yesifuba.

Imingcipheko yempilo edibene nokuchanabeka kwiradiyeyishini ngenxa yomsebenzi owenziwa eKoeberg iphantsi kakhulu kuba idowusi oluchanabeke kuyo uluntu incinci kakhulu. Umda wedowusi yoqobo obekwe ngumthetho kuluntu ngenxa yazo zonke izinto ezigunyazisiweyo ezenziwayo yi-1 mSv ngonyaka, ngelixa isithintelo sedowusi yomntu ngamnye osebenza eKoeberg kumntu ongummeli iyi-0,25 mSv ngonyaka [7]. Isithintelo sedowusi eyi-0,25 mSv injongo yayo kukuqiniseka ukuba iyonke imithombo enokuba negalelo ekuchanabekeni komntu ongummeli ihlala ingaphantsi komda wedowusi oyi-1 mSv ngonyaka.

Imigangatho yokhuseleko kunye nezenzo zolawulo olukwimiyalelo (safety standards and regulatory practices [SSRP]) [7] olukhutshwe ngokoMthetho WeNNR ifuna kuthathwe amanyathelo ahambelane nobukhulu namathuba okuchanabeka ukuze kuqinisekiswe ukuba ukuchanabeka okudibene nomsebenzi waseKoeberg kugcinwa kwiALARA, sele kuqwalaselwe imiba yoqoqosho neyentlalo.

Loo nto ithetha ukuba kufanele kuthathwe onke amanyathelo afanelekileyo ukuze kulungiswe ukhuselo lweradiyeyishini ukuze lusebenze kangangoko, kwaye loo nto ingaquka ukuqonda umthombo weradiyeyishini, iindlela ekungakhethwa kuzo zokufikelela kwisiphumo esinqwenelekayo, iindlela zokubeka esweni nezokulinganisa, nokugquma.

Ukongezelela koko, njengenxalenye yomsebenzi oqhelekileyo, iKoeberg ikhupha imichiza yerhasi kwakunye namanzi angcoliswe yiradiyeyishini alahlwa kokusingqongileyo phantsi kweemeko ezilawulwayo nezibekwe esweni ukuze kuqinisekiswe ukuba umngcipheko kuluntu uphantsi kangangoko kunokwenzeka. Imichiza yeerhasi kwakunye namanzi angcoliswe yiradiyeyishini ezikhutshwayo zigcinwa zingaphantsi kwemida yonyaka egunyazisiweyo yezinto ezichithwayo (annual authorised discharge quantities [AADQ]), nto leyo eqinisekisa ukuba uyathotyelwa umda wonyaka wedowusi yoqobo. IiAADQ yimida yolawulo esekiweyo, yaye ifuthe kokusingqongileyo luncinci kwaye luthathwa njengolukhuselekileyo xa zikhutshwa ngomlinganiselo ongaphantsi kwale mida. EKoeberg, idowusi enxulumene namanzi angcoliswe yiradiyeyishini alahlwayo ibalwa ngokwekota nangokonyaka kwaye neNNR iyayinikwa ingxelo yezi ziphumo. Idowusi kawonke wonke ebangelwa kukuchithwa kwamanzi angcoliswe yiradiyeyishini yaseKoeberg iboniswe kuUmfanekiso 14 kwixesha elisusela ku 2009 ukuya ku 2020.



Umfanekiso 14: Ukuchanabeka koluntu ngenxa yomsebenzi owenziwa eKoeberg

Iziphumo zibonisa ukuba idowusi yeradiyeyishini ingaphantsi kakhulu kwisithithentelo sedowusi esiyi-0,25 mSv ngonyaka samanzi angcoliswe yiradiyeyishini achithwayo. Iidowusi ziyancipha (ziphucuke) ekuhambeni kwexesha ngenxa yokuncitshiswa kwamanzi angcoliswe yiradiyeyishini achithwayo okwenziwe ngokuphuculwa kokuthembeka kweetyhubhu zamafutha enyukliya. Oku kuphucula (ukuncipha kwenkcitho eneradiyeyishini) ngokuhamba kwexesha kungumzekelo weenzuzo efunyanwa zizitishi zombane wenyukliya kwindlela yazo yokuziphatha yokwabelana ngamava omsebenzi phakathi kwazo, yaye kule meko, nokuchazela abavelisi bamafutha enyukliya ukuze baphucule ukhuseleko nendlela abasebenza ngayo. Uhlolo olwenziwe kamva lwedowusi lubonise ukuba, kule minyaka ilishumi idlulileyo, idowusi yoluntu iye yaqhubeka ingaphantsi kwe-1% yomda wedowusi yoluntu oyi-1 mSv ngonyaka.

Idowusi kawonke-wonke (ebizwa ngokuba luhlolo olwenziwe kamva lwedowusi) isekelwa kweyona nuclide ikhutshiweyo elinganiswe ngexesha ekufakwa ingxelo ngalo

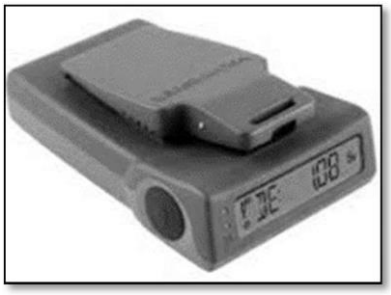
esitishini, kucingwa ngezilwanyana nezityalo eziphila kwisizasaseDuynefonteyn, kunye nembali yokuphehla umbane yeKoeberg neemeko zokusasazeka kokusingqongileyo ebezikho ngexesha ekufakwa ngalo ingxelo.

Uhlobo lwemisebenzi eyenziwa eKoeberg akulindelwanga ukuba itshintshe ebudeni beLTO; ngako oko, inkcitho engcoliswe yiradiyeyishini ekhutshwayo kwixesha elizayo akulindelekanga ukuba ichaphazeleke kakubi, kwaye idowusi kawonke-wonke eqikelelwayo yonyaka kulindelwe ukuba kwaye ngaphantsi kakhulu kumda obekwa yimiyalelo ebudeni beLTO. (Jonga necandelo 10.3.)

10.1.7. Ukuchanabeka kwiradiyeyishini emsebenzini

Nangona kulindeleke ukuba idowusi yasemsebenzini inyuke ngexesha elifutshane ngenxa yomsebenzi ingakumbi wokutshintsha nokuphucula ubuxhakaxhaka boomatshini neekhomponenti zesitishi, akulindelwanga ukuba inyuke kakhulu, kwaye umyinge wedowusi yolawulo obekiweyo awuyi kugqithwa nangaliphi na ixesha ebudeni beLTO.

Abasebenzi abaqeshwe kwaEskom (abaqeshwe isigxina kwakunye neekontraka) njengabasebenzi beradiyeyishini baye bahlolwe impilo ukuze kufikwe kwisigqibo sokuba bakulungele na ukusebenza kwiindawo ezineradiyeyishini. Ngaphambi kokuba basebenze kummandla oneradiyeyishini, abasebenzi bayaqeqeshwa baze bagunyaziswe njengabasebenzi beradiyeyishini. Le nto yenza abasebenzi bafunde baze baqonde iingozi ezidibene nokusebenza ngeradiyeyishini ekumanqanaba aphezulu kwaye bazi nokuba ngawaphi amanyathelo akhoyo okubakhusela. Abasebenzi beradiyeyishini banikwa izixhobo zokuzikhusela ezifana nedowusimitha ye-elektroniki eyeyabo kunye ne-thermo-luminescent detector eziboniswe Umfanekiso 15 Umfanekiso 16, ngokulandelelana kwayo. Ezi zixhobo zinxitywa ukuze kubekwe esweni amanqanaba edowusi yeradiyeyishini efunyanwa ngabasebenzixa besebenza kwimimandla evelisa iradiyeyishini (eyaziwa ngokuba yimimandla elawulwayo).



Umfanekiso 15: Idowusimitha ye-elektroniki yomntu (iEPD)

Umfanekiso 16: Idowusimitha ye-thermo-luminescent (TLD)

Abasebenzi beradiyeyishini abenza umsebenzi kummandla olawulwayo, banikwa nezixhobo zokukhusela imizimba ezihambelana nokhuseleko olufunekayo ukuze kuthintelwe ukususuleleka yiradiyeyishini kunye nokuqaphela isixa sedowusi abayifumanayo ngalo lonke ixesha.

Ukuze kuncitshiswe imiphumela eyingozi yeradiyeyishini xa kuphathwa imithombo yeradiyeyishini, lemiba ilandelayo “ixesha, umgama, nokugquma" exhasa umgaqo weALARA wokhuseleko lwe radiyeyishini ibekwe elisweni, engacaciswa ngolu hlobo:

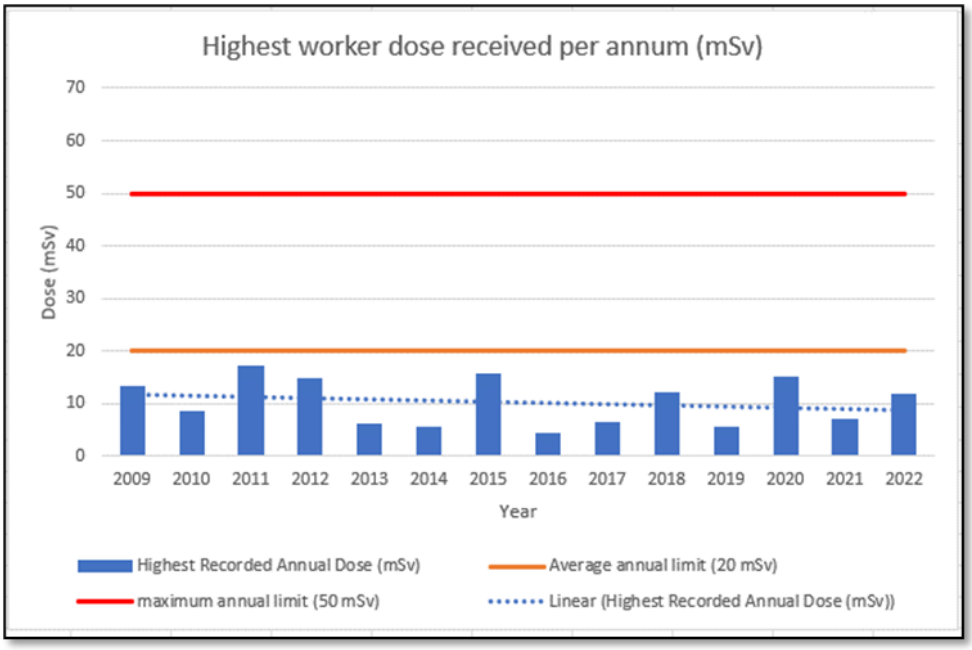
Okukhona lilide ixesha umntu alichitha kufutshane nomthombo weradiyeyishini, kukhona isiya ibaninzi idowusi ayifumanayo kuze, ngenxa yoko, ube phezulu umngcipheko kwimpilo.

Okukhona umfutshane umgama phakathi komthombo weradiyeyishini nomntu osebenzayo, kukhona isiyaa ibaninzi idowusi ayifumanayo kwaye usiba phezulu umngcipheko kwimpilo.

Okukhona ingqindilili imathiriyali azigqume ngayo umntu kuhlobo oluthile lweradiyeyishini, kukhona lungcono ukhuseleko kwingozi yeradiyeyishini.

Xa kulindelekile ngokwezicwangciiso neemfuno zomsebenzi ukuba abantu basebenze kwindawo apho bafumana khona idowusi, owona myinge uphezulu wedowusi yomntu omnye yi-

20 mSv ngonyaka ebalwa ngokomlinganiselo ophakathi kwixesha elisikiweyo leminyaka emihlanu (100 mSv kwiminyaka emihlanu), kukho umqathango othi idowusi ayifanelanga idlule ku-50 mSv ngawo nawuphi unyaka omnye. Iidowusi zabasebenzi baseKoeberg zingaphantsi kwemida yolawulo ebekiweyo; umzekelo, eyona dowusi iphezulu ibiyi-17 mSv ngo 2011 (umda uthi 50 mSv). Umfanekiso 17 ubonisa ezona dowusi zabasebenzi ziphezulu phakathi kuka 2009 no 2020. Kukho ukuncipha (ukuphucula) ebudeni beli xesha.

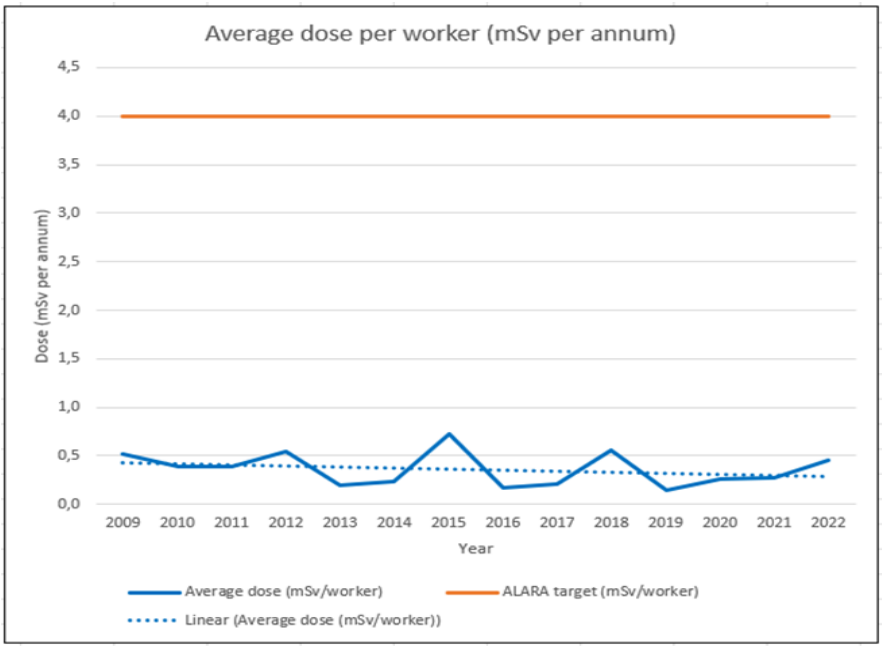


Umfanekiso 17: Eyona dowusi iphezulu ifunyenwe ngumsebenzi ngonyaka

I-ALARA ijolise kumlinganiselo ophakathi wonyaka eyi-4 mSv kwidowusi yabasebenzi [5]. Eli nani kujoliswe kulo lingaphantsi kakhulu kumyinge wedowusi oyi-20 mSv ngonyaka kubasebenzi kubalwa umlinganiselo ophakathi yeminyaka emihlanu elandelanayo. IKoeberg ibisoloko ilifikelela kweli nani ledowusi ekujoliswe kulo eliyi-4 mSv kwixesha lokuhlola elisusela ku 2009 ukuya ku-2020, njengoko kubonisiwe kuMfanekiso 18. Umlinganiselo ophakathi wedowusi ungaphantsi kwe-1 mSv kumsebenzi ngamnye ngonyaka. Ukongezelela koko, umgangatho uyaphucuka (idowusi yeradiyeyishini iyancipha) ngokuhamba kwexesha ngenxa yamanyathelo okunciphisa idowusi yeradiyeyishini aye athathwa eKoeberg.

Imida yolawulo ebekiweyo kwakunye neezinto ekojoliswe kuzo zolawulo lwedowusi yabasebenzi kulindeleke ukuba iqhubeke injalo ebudeni bexesha leLTO, kwaye idowusi yasemsebenzini kulindeleke ukuba ihlale ingaphantsi kwemiyinge yolawulo ebekiweyo

kwakunye nezinto ezijolisiweyo ngalo lonke ixesha leLTO. i-PSR (Inkqubo yokuhlola ukhuseleko yamaxesha-ngamaxesha engqamene ne LTO), ihlole inkqubo yokukhusela kwiradiyeyishini yaza yayifumanisa ihambisana noko kufunwa ngamazwe ngamazwe, lilizwe nayimiqathango yolawulo. Imigaqo esisiseko yokukhusela kwiradiyeyishini (into ethethelela ubukho bayo, ukusebenzisa kangangoko, nemida yedowusi) iza kusetyenziswa ngokungqongqo ukuze kuqinisekiswe ukuba idowusi ifunyanwa kuphela xa kukho inzuzo naxa kungekho mngcipheko ungafanelekanga kubasebenzi okanye kuluntu.



Umfanekiso 18: Iavareji yedowusi yomsebenzi ngamnye ngonyaka (mSv)

10.2 Ifuthe leLTO kokusingqongileyo

IKoeberg izibophelele kumgaqo-nkqubo othi kungenziwa monakalo kokusingqongileyo nowokuba kuqinisekiswe ukuba ukukhuseleka kwiradiyeyishini kuba kwindawo yokuqala. Inkqubo yokulawula okusingqongileyo ihambelana ne-ISO 14001 (umgangatho wamazwe ngamazwe ochaza izinto ezifunekayo kwinkqubo esebenzayo yokulawula okusingqongileyo). Inkqubo yayo yolawulo edityanisiweyo ihambelana ne -ISO 9001 (umgangatho wamazwe ngamazwe ochaza izinto ezifunekayo kwinkqubo elawula umgangatho) kwakunye ne-RD- 0034 (uxwebhu lweNNR oluthetha ngomgangatho nezinto ezifunekayo kulawulo lokhuseleko eKoeberg) [11].

Ifuthe lomsebenzi owenziwa kwesi sitishi kwiinkalo ezahlukeneyo zokusingqongileyo liye lahlolwa kusenzelwa iLTO ukuze kungqinwe ukuba izinto ezichithwa kokusingqongileyo ezineradiyeyishini nezingenaradiyeyishini zingaphantsi kwemida ebekiweyo kwaye zihambelana nemigaqo ebekwe ngamagunya alawulayo.

IKoeberg inenkqubo esebenzayo yokubeka esweni ifuthe lenkcitho yamanzi angcoliswe yiradiyeyishini ezichithelwa kokusingqongileyo, njengoko kufunwa yimigangatho yokhuseleko naluqheliselo olufunwa kwimiyalelo yeSSRP ebekwe yaze yaziswa ngokoMthetho We-NNR [7]. Iinkqubo zaseKoeberg zokulawula inkcitho engcoliswe yiradiyeyishini ekhutshwayo zinexesha zisetyenziswa kwaye ziyaqinisekisa ukuba inkcitho engcoliswe yiradiyeyishini ekhutshwayo ayigqithi kwimida ebekwa yolawulo ebekiweyo nakwi-ALARA. Eli candelo lilandelayo liza kubonisa ukuba ifuthe kokusingqongileyo ngenxa yomsebenzi owenziwa ngoku eKoeberg lincinci kwaye lingaphantsi kakhulu kwimida ebekwe yimiyalelo yaye kulindeleke ukuba liqhubeke lingaphantsi kakhulu kwimida ebekwa yimiyalelo ngalo lonke ixesha leLTO.

IKoeberg izibophelele kumgaqo-nkqubo othi kungenziwa monakalo kokusingqongileyo nowokuba kuqinisekiswe ukuba ukukhuseleka kwiradiyeyishini kuba kwindawo yokuqala. Inkqubo yokulawula okusingqongileyo ihambelana ne-ISO 14001 (umgangatho wamazwe ngamazwe ochaza izinto ezifunekayo kwinkqubo esebenzayo yokulawula okusingqongileyo). Inkqubo yayo yolawulo edityanisiweyo ihambelana ne -ISO 9001 (umgangatho wamazwe ngamazwe ochaza izinto ezifunekayo kwinkqubo elawula umgangatho) kwakunye ne-RD- 0034 (uxwebhu lweNNR oluthetha ngomgangatho nezinto ezifunekayo kulawulo lokhuseleko eKoeberg) [11].

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10.2.1. Imida ebekiweyo yenkcitho engcoliswe yiradiyeyishini ekhutshelwakokusingqongileyo xa kusetyenzwa

Njengenxalenye yomsebenzi oqhelekileyo, iKoeberg ikhupha kokubini imichiza yeerhasi namanzi angcoliswe yiradiyeyishini ezikhutshelwa kokusingqongileyo phantsi

kweemeko ezilawulwayo nezibekwe esweni ukuze kuqinisekiswe ukuba idowusi kuluntu iphantsi kangangoko kunokwenzeka ALARA nefuthe layo kokusingqongileyo licuthekile, nomthamo ungokwemilinganiselo yemigaqo-nkqubo. Imichiza yeerhasi kunye namanzi angcoliswe yiradiyeyishini ezikhutshwayo kufuneka zihambisane nemida yonyaka egunyazisiweyo yezinto ezichithwayo (iiAADQ), ethobela umda wonyaka wedowusi yoqobo ebekwe kwiSSRP [7].

Njengoko kutshiwo kwicandelo 10.2.3, umda wedowusi yoqobo kuluntu ngenxa yazo zonke izenzo ezigunyazisiweyo yi-1 mSv ngonyaka, ngelilixa isithintelo sedowusi yomntu ngamnye osebenza eKoeberg kumntu ongummeli iyi-0,25 mSv ngonyaka [7]. Esi sithintelo sedowusi yesibini injongo yaso kukuqiniseka ukuba iyonke imithombo enokuba negalelo ekuchanabekeni komntu ongummeli ihlala ingaphantsi komda wedowusi oyi-1 mSv ngonyaka.

Iinkqubo ezibeka esweni inkcitho engcoliswe yiradiyeyishini echithwa yiKoeberg kokusingqongileyo ziye zahlolwa kwiPSR. I-PSR ingqinile ukuba idowusi yonyaka eqikelelwayo kusetyenziswa ulwazi ngenkcitho yamanzi angcoliswe yiradiyeyishini ekhutshwayo nogxininiso kokusingqongileyo kule minyaka ilishumi edluleyo ibingaphantsi kwe-1% ye-1 mSv ngonyaka yomda wedowusi yoluntu, kwaye ingaphantsi kakhulu kwinqanaba leradiyeyishini efumaneka kwindalo. Kuba imida yolawulo yedowusi ebekiweyo ihambisana nemigangatho yamazwe ngamazwe, akulindelekanga ukuba itshintshe ebudeni beLTO, yayee akukhomfuneko yokutshintsha iinkqubo ezibeka esweni inkcitho engcoliswe yiradiyeyishini ekhutshwayo nokusingqongileyo ingakumbi kwiLTO.

Nangona kunjalo, kukho amanyathelo athathwayo ukuze kuphuculwe ukubekwa esweni kwamanzi angaphantsi komhlaba kwisiza saseKoeberg kwaye kuqukwe ii-nuclide ezingakumbi xa kubekwa esweni inkcitho engcoliswe yiradiyeyishini ekhutshwayo naxa kuhlolwa idowusi. Oku kusesekelwe kwiingcebiso zePSR yakutshanje ukuze ichongwe kwaye iphawuleke ngcono inkcitho engcoliswe yiradiyeyishini ekhutshwayo.

10.2.2. Ukubeka esweni imichiza yerhasi namanzi angcoliswe yiradiyeyishini ukuze kulawulwe inkcitho ekhutshwayo

IKoeberg inesakhiwo esikhulu esimileyo esigubungelayo, nto leyo ethintela ukuphuma kwee- radionuclides xa kunokwenzeka ingozi. Nangona kunjalo, xa kusetyenzwa ngendlela eqhelekileyo kwesi sitishi sombane kufuneka kukhutshwe ezinye iinkcithoo zamanzi angcoliswe yiradiyeyishini phantsi kweemeko ezilawulwayo kusetyenziswa iinkqubo zokubeka esweni inkcitho eneradiyeyishini echithwayo. Nangona uninzi lwe-radioactivity luphelela ngaphakathi kwee-pellet zamafutha enyukliya neetyhubhu, intwana ye-radioactivity iyaphuncuka kwii-fuel rods ize ingcolise amanzi apholisa iriyektha.

Ngaphandle kwe- radioactivity evela kumafutha, amanzi apholisa isekethi eyintloko (primary coolant system) nawo angcoliswa yiradiyeyishini evela kwii-neutron.

Ukulawulwa kwerhasi elahlwayo eneradiyeyishini

Inkqubo yokulawula inkcitho yerhasi eneradeyeyishini ekhutshwayo iqokelela iirhasi ezineradiyeyishini kumanzi apholisa iriyektha kwisekethi eyintloko. Ezi rhasi ziyakhutshwa zize zithunyelwe kwiitanki ezimbini ezigcina iirhasi. Ezi tanki zimbini zizigcinayo zivumela iirhasi ezinesiqingatha sobomi esifutshane ziphelelwe ngamandla enyukliya ukuba ixesha liyavuma, ngokuqhelekileyo kushiyeke intwana yee-radionuclide ezinesiqingatha sobomi eside ukuze zikhutshwe ziye emoyeni phantsi kweemeko ezilawulwayo nangemida evumelekileyo.

ILTO ayiyi kuzandisa iirhasi ezineradiyeyishini ezikhutshwayo kuba umthombo oyintloko ngamafutha enyukliiya, kwaye ukuthembeka kweetyhubhu zamafutha kuye kwaphucuka ngokuhamba kwexesha, kwabangela ukuba zinciphe iirhasi ezineradiyeyishini eziphumela

kwisekethi eyintloko. Ukuphucula okwenziwe ekuthembekeni kweetyhubhu zamafutha kubangelwe kukuphuculwa koyilo lwazo naziinkqubo zokuzivelisa.

Ulawulo lwamanzi angcoliswe yiradiyeyishini

I-radioactivity ekwisekethe eyintloko ngomnye wemithombo ephambili wamanzi angcoliswe yiradiyeyishini achithwayo. Ngaphandle kwentwana ye-*radioactivity* esembindini, omnye umthombo ongundoqo weradiyeyishini ngamanzi akwisekethi eyintloko apholisa iriyektha. Amanzi angcoliswe yiradiyeyishini akhutshwayo alawulwa ziinkqubo noosinga-nkqubo bemichiza echithwayo. Umgama neentlobo zokusetyenzwa zixhomekeka kulwakhiwo lwemichiza neyee-radionuclide kulo michiza ichithwayo. Ukusetyenzwa ngakumbi kwamanzi angcoliswe yiradiyeyishini achithwayo kunganciphisa iradiyeyishini ephumayo, kodwa le nkqubo inemida eyisikelweyo, kuba ezinye ii-radionuclide ezifana ne-tritium azahluleki, kwaye nokuyisebenza okuthe chatha kungakhokelela kwi-*radioactivity* engaphezulu, nokuchaphazeleka kwabasebenzi. Ngamanye amaxesha kufuneka uthenge emithiyo ngenethole kule meko ngokuthi usebenzise umgaqo weALARA.

Uyilo neyona meko bukuyo ubuxhakaxhaka boomatshini bokucoca imichiza eneradiyeyishini elahlwayo ziye zahlolwa kwiPSR. I-PSR ifumanise ukuba uyilo neyona meko kukuyo kubuxhakaxhaka boomatshini bokucoca imichiza eneradiyeyishini elahlwayo lukumgangatho owamkelekileyo ngexesha leLTO. Kodwa ke ukuqhubeka kuphuculwa kuza kuqwalaselwa kwiinkqubo zokulawula inkcitho eneradiyeyishini elahlwayo njengenxalenye yokuqhubeka kweKoeberg inciphisa inkcitho eneradiyeyishini ekhutshelwa kokusingqongileyo.

10.2.3. Ifuthe kokusingqongileyo ngenxa yomsebenzi omkhulu wokutshintsha nokuphuculwa kobuxhakaxhaka boomatshini besitishi kusenzelwa iLTO

Njengokuba sekutshiwo, iKoeberg iye yazibophelela kwaye iza kuqhubeka izibophelela kumsebenzi omkhulu wokuhlaziya ukuze kuqinisekiswe ukuba iKoeberg ikwimeko entle kwaye iza kuqhubeka isebenza ngendlela ekhuselekileyo nethembekileyo ebudeni bayo yonke iLTO, ukuba iNNR iyayigunyazisa.

Iikhomponenti ezitshintshwayo (ezinjengeenjini zomphunga) kungenzeka ukwakheka kwazo kwahluke kwiikhomponenti ebezikho kuqala, nto leyo engadala ukuba kubekho utshintsho kwiimveliso ezineradiyeyishini ezifumaneka kwinkcitho eneradiyeyishini. Ukwanda okwexeshana komthamo wenkcitho eneradiyeyishini, ubukhulu becala ebudeni besigaba sokufakela, nako kungenzeka. Iprojekthi (Uluhlu lwemisebenzi eyenziwayo xa kutshintsha ikhomponenti) nganye yolu hlobo iyayiqwalasela le nto ukuze iqiniseke ukuba incinci inkcitho eneradiyeyishini echithwayo nokuba ifuthe kwi-AADQ liyaqondwa kwaye ligcinwa lingaphantsi kwemida.

Ukuchanabeka kwemathiriyali yeenjini zokwenza umphunga ezintsha kwisekethi yamanzi apholisa iriyektha okwexeshana kuza kubangela ukuba amanzi esekethi eyintloko apholisa iriyektha abe neradiyeyishini ephezulu. Eli futhe liye lahlolwa, yaye kugqitywe ekubeni ukwanda kwenkcitho engamanzi aneradiyeyishini echithwayo kuncinci kwaye

kusengaphantsi kakhulu kwii-AADQ. Ifuthe ledowusi yoluntu nalo lafunyaniswa liluncinane kwaye lingaphantsi kakhulu kwimida yolawulo ebekiweyo.

Ukutshintshwa kweekhomponenti ezinkulu kungaphumela ekubeni kufuneke iindawo ezinkulu zokubeka izinto kunye nezakhiwo ezintsha zokugcina izixhobo zokusebenza okanye zokuzivelisa. Kungenzeka kufuneke ii-crane ezinkulu. Yonke le misebenzi iyahlolwa ukuze kubonwe ifuthe engaba nalo kokusingqongileyo. Ukuza kuthi ga ngoku, iiprojekthi ezimbini ezinjalo ziye zafuna ukuba kucelwe isigunyaziso sokusingqongileyo ngokoMthetho Welizwe Wolawulo Lokusingqongileyo 108 wango-1998. Iprojekthi yokuqala kukwandiswa kwendawo yokumisa iimoto ukuze kulungiselelwe abasebenzi abaninzi abaza kube besebenza kwiiprojekthi zokutshintsha iikhomponenti, ize enye iprojekthi kwaye kukutshintshwa kweyadi yombane onamandla kakhulu engekaqalwa. Ukwandiswa kwendawo yokupaka iimoto akunafuthe kokusingqongileyo, kwaye akuyomfuneko ukucela isigunyaziso kwiNNR.

10.2.4. Ifuthe kokusingqongileyo ngenxa yokuguga kobuxhakaxhka boomatshini neekhomponenti

KwiLTO, kujoliswa ngamandla ekulawuleni imiphumela emibi yokuguga kobuxhakaxhaka beematshini neekhomponenti zesitishii. Ubuxhakaxhaka beematshini neekhomponenti zesitishi ezisetyenziselwa ukucoca inkcitho engamanzi aneradiyeyishini nokuyichitha zihloliwe kwiPSR. Ezona khomponenti zesitishi ezingachaphazela okusingqongileyo ngenxa yokuguga zii-evaporators zobuxhakaxhaka boomatshini bokucoca kwenkcitho engamanzi aneradiyeyishini achithwayo kunye nezakhiwo, apho izakhiwo zingumqobo phakathi kwemathiriyali eneradiyeyishini nokusingqongileyo.

Ezi evaporators azisebenzi kakuhle, kodwa obubuxhakaxhaka boomatshini obukhoyo busaqhubeka busebenza ngokwaneleyo kuba ii-demineralisers ezigudle lo mjelo ziyancedisa koku kuqhwalela kwee-evaporators. IPSR icebe ukuthatha amanyathelo ukuze kuphuculwe ukusebenza kwee-evaporators.

Izakhiwo ziye ziguge ngokuhamba kwexesha, ngokukodwa xa zichanabeke (exposed) kokusingqongileyo okuqatha. Ukuncitshiswa kwefuthe ngokubeka esweni imeko yezakhiwo nangokulungisa qho kuyenziwa ukuze kungafane kwenzeke ukuba kubekho inkcitho eneradiyeyishini echithwayo ephumela kokusingqongileyo ngezakhiwo engacwangciswanga.

10.2.5. I-radioactivity kokusingqongileyo ngenxa yeLTO

Ukuqokelelana kwe-radioactivity kwizinto eziphilayo kwaziwa ngokuba yi-bioaccumulation. Ezinye ii-radionuclides (iikhemikhali ezineradiyeyishini) ezikhutshelwa kokusingqongileyo zineempawu ezibangela ukuba i-bioaccumulation ibephezulu kunezinye (ukuqokelelana kwekhemikhali kwizinto eziphilayo). Isiqingatha sobomi se-radionuclide (ixesha elifunekayo ukuze iiathomu ezineradiyeyishini ziphelelwe ngamandla enyukliya) kunye nesiqingatha sobomi emzimbeni (ixesha elithathwa sisiqingatha se-radionuclide ukuba ikhutshwe kwisidalwa) zizinto ekubalulekileyo ukuziqwalasela xa kucingwa ngefuthe kokusingqongileyo. Inkqubo yokubeka esweni okusingqongileyo ikhona, ijonga ubungakanani bee-radionuclide kwiisampulu ezithathwe kokusingqongileyo kwisizai saseKoeberg (jonga icandelo 10.3.7).

Njengoko kuchaziwe ngasentla, ukuqokelelana kwenzeka kokusingqongileyo ngenxa yokuba ezinye iiradionuclide zinesiqingatha sobomi obude. Ukuqaphela ukuphelelwa ngamandla kweradiyeyishini, ulungelelwaniso lweradioactivity kokusingqongileyo

lwenzeka ngaphambili kweminyaka eyi-40 yokusebenza kwee-radionuclide ezinesiqingatha sobomi esingaphantsi kweminyaka eyi-10. Akukho okunye ukuqokelelana kwe-radioactivity okubangelwa yi- bioaccumulation ebudeni beLTO kwezi nuclides zinesiqingatha sobomi esifutshane.

Ii-*radionuclides* ezinesiqingatha sobomi eside kuneminyaka eyi-10 nesineempawu ezidala i- bioaccumulation ephezulu zingadala umngcipheko kokusingqongileyo ngenxa yeLTO. Ezi yi- carbon-14 (isiqingatha sobomi bayo yiminyaka eyi-5 730), i-strontium-90 (isiqingatha sobomi bayo yiminyaka eyi-29), i-caesium-137 (isiqingatha sobomi bayo yiminyaka eyi-30), ne-nickel-

63 (isiqingatha sobomi bayo yiminyaka eyi-96). Nangona kunjalo, kukho ukwanda okuncinci ekuqokelelekeni kwe-radioactivity kwimo-ntlalo yaselwandle okulindelekileyo ngenxa yeLTO kwezinye ii-nuclides ezibalulekileyo kunezinye ezihlala ixesha elide, njengoko kuboniswe kwiTheyibhuli 4. Ifuthe loku kuqokolelana kwisityalo nakwisilwanyana sokuzekelisa libonakele lilincinane.

Itheyibhile 4: Ukwanda okuqikelelwayo kwe-radioactivity kokusingqongileyo kwaselwandle xa kusetyenzwa iminyaka eyi-60 xa kuthelekiswa neyi-40 kwiinuclides ezibalulekileyo ezinesiqingatha sobomi eside.

I-radionuclide	Ukwanda kwepesenti kwintlabathi yolwandle	Ukwanda kwepesenti kwii-crustacean nakwiintlanzi	Ukwanda kwepesenti kukhula lwaselwandle	Ukwanda kwepesenti kwii-mollusc
C-14	1,2	0,0	0,0	0,0
Cs-137	2,3	0,0	0,0	0,0
Ni-63	5,8	0,3	0,1	0,0
Sr-90	1,3	0,0	0,0	0,0

Ithamo elilindeleke kuluntu libalwe kuqwalaselwe uqokolelwano lweenuclides kokusingqongileyo ukuya kutsho kwiminyaka eyi-60 yeLTO. Ngokwahlukileyo kwidowusi yoluntu ebalwa emva kwexesha, esekelwe kwiisampulu zoqobo nakumanani emichiza echithiweyo, idowusi yoluntu elindelekileyo isekelwe kuqikelelo, ngokomzekelo, inkcitho engamanzi aneradiyeyishini ezakukhutshwa kwixesha elizayo. Idowusi elindelekileyo kwiLTO iqikelelwe kucingelwa eyona meko imbi lwaba yi-0,094 mSv ngonyaka, engaphantsi kwedowusi yesithintelo eyi-0,25 mSv ngonyaka.

Inkqubo yokubeka esweni iradiyeyishini kokusingqongileyo ijonga ubuninzi bee-radionuclide kwiisampulu zokusingqongileyo ize ilandele nakuphi na ukuqokolelana okubalulekileyo kokusingqongileyo kumsebenzi oqhelekileyo. Inkqubo yokubeka

esweni iradiyeyishini iza kulubona utshintsho oluphawulekayo kwimikhwa ye-bioaccumulation ebudeni bexesha leLTO xa lunokwenzeka.

Kwenziwe uphononongo ukuze kugqithwe ngefuthe ledowusi kwizityalo nezilwanyana. Ifuthe ledowusi ngenxa yokuqokolelana kwee-radionuclide iminyaka eyi-60 kuye kwahlolwa. Uhlolo lubonise ukuba idowusi kwisilwanyana nakwisityalo sembekiselo ingaphantsi kwenani ledowusi lokuhluza eliyi-40/400 µGy/h yeIAEA neKomiti Ekhethekileyo Yezizwe Ezimanyeneyo Ejongene Nemiphumela Yeradiyeyishini Yeeathom (The United Nations special committee on the effects of atomic radiation [UNSCEAR]).

10.2.6. Ifuthe leLTO ekusetyenzisweni komhlaba ojikeleze iKoeberg

Inkqubo yokubeka esweni okusingqongileyo eKoeberg iyasetyenziswa ukuze kubekwe esweni zonke iindlela zokuchanabeka ezibalulekileyo. Ezi ndlela zingatshintsha ngamaxesha athile kuxhomekeka ekutshintsheni kwemisebenzi eyenziwa ngabantu kufutshane nesi sitishi sombane naxa kwenziwe utshintsho olubalulekileyo kwesi sitishi. Ngokuhambisana noko kufunwa yimiyalelo, ukuhlolwa kwendlela osetyenziswa ngayo umhlaba okwisithuba seekhilomitha eyi-10 ukusuka kwesi sitishi sombane qho ngonyaka kuyenziwa. Injongo yolu phononongo lomhlaba kukukhangela iindlela ezintsha osetyenziswa ngazo, utshintsho kwiindawo ezikuzo ii-receptors, okanye iindlela ezintsha zochanabeko.

Iziphumo zePSR (ngo- 2009 ukuya 2019) zibonise ukuba akubangakho imithombo okanye iindlela ezintsha ezibalaseleyo ezifuna ukuba kuhlolwe isampulu yendawo. Umsebenzi wezolimo kufutshane nesi sitishi sombane awutshintshanga ngenxa yomgangatho ophantsi womhlaba ojikeleze esi sitishi sombane nemiqathango ethintela uphuhliso ebekwe kwisicwangciso yemeko yongxamiseko.

Amathuba okwakha indawo yokuhluza ityuwa emanzini olwandle kufutshane neKoeberg ahloliwe kwaza akwafunyanwa tshintsho ekusetyenzisweni komhlaba oluchatshazelwa yidowusi yoluntu.

Naluphi na utshintsho olungenzeka luza kubonwa ebudeni bohlolo lonyaka yaye ifuthe lalo liza kuhlolwa ngelo xesha. Kodwa ke, akulindelekanga ukuba kwenzeke izinto ezintsha ebudeni bexesha leLTO ezingeza neendlela ezintsha zokuchanabeka.

10.2.7. Inkqubo yokubeka esweni okusingqongileyo

IKoeberg inenkqubo yokubeka esweni okusingqongileyo ukuze kuhlolwe imiphumo yeradiyeyishini ebangelwa yinkcitho eneradiyeyishini ekhutshelwa kokusingqongileyo. Le nkqubo yanelisa imiqathango esekwe yiNNR kwakunye naleyo isekwe yi-IAEA.

Iisampulu ezithathwe yilabhoratri yophononongo lokusingqongileyo eKoeberg ziquka iindlela zokuchanabeka ngokusezela, ukuginya, nangokungqalileyo. Iisampulu ezithathwe kwiindawo ezahlukeneyo nangamaxesha angafaniyo ziquka ezi zinto zilandelayo:

- Umoya
- Amanzi okusela
- Umphezulu wamanzi
- Ubisi
- Iintlanzi
- Umhlaba
- Intlabathi ephantsi elwandle
- Imifuno enamagqabi abanzi
- Ukutya okuveliswa kulo mmandla
- Amanani eradiyeyishini kusetyenziswa iidosimitha ze-thermo-luminescent

Ingxelo yeziphumo zeesampulu inikelwa kwiNNR ngekota nangonyaka. Iziphumo zazo zonke iisampulu ezithathwe kwixesha lengxelo yePSR yokugqibela (2009 ukuya ku 2019), nezibangelwa umsebenzi owenziwa eKoeberg, bezingaphantsi kwe-10% yamanqanaba afanele axelwe kwaye akukho nkxalabo kokusingqongileyo okanye kuluntu.

Inkqubo yokubeka esweni okusingqongileyo ijonga ubuninzi bee-radionuclides kwiisampulu zokusingqongileyo yaye iza kuqhubeka ikhangela nakuphi na ukuqokolelana okubalulekileyo kokusingqongileyo ebudeni bexesha leLTO.

11. IZIZATHU ZOBUGCISA EZIXHASA UKWANDISWA KWEXESHA LOKUSEBENZISA ESI SITISHI

Esi sahluko sishwankathela ukuxhaswa kweLTO ngobugcisa. Sichaza iziphumo ezingundoqo zobugcisa ezivela kuhlolo, sijolisa kulawulo lweSALTO lokuguga neziphumo zePSR. Ukongezelela koku, ukhuseleko lokoqobo nolweekhompyutha luza kushukuxwa kancinane ngenxa yokuba ingumbandela onkenenkene lo. Imingcipheko yokhuseleko lwenyukliya, lwempilo, neyokusingqongileyo ishukuxwa kwiSahluko 10 aze amalungiselelo enkampani eLTO achazwe kwiSahluko 12.

11.1 Uyilo lweKoeberg

Uyilo lwaseKoeberg luyafana neyezinye iiyunithi zeeriyektha zenyukliya ezisehlabathini jikelele, ngokukodwa ezaseFransi. Yinxalenye yeqela leeriyektha zamanzi axinzelelweyo ezivelisa i-900 MW, nezinamacandelo amathathu ezakhiwa nguFramatome kwiminyaka yoo-1970 noo-1980 ngokukodwa eFransi nezibhexeshwa yinkampani ephehla umbane yamaFrentshi, iÉlectricité de France (EDF). Zinembali yokusebenza ngendlela enokuthenjwa, nekhuselekileyo. Uyilo lwesitishi saseKoeberg luye lwahlolwa ebudeni bePSR ukuze kubonwe ukuba iisistimu zesi sitishi, izakhiwo, neekhomponenti ezibalulekileyo ekusebenzeni ngendlela ekhuselekileyo ziyilwe ngendlela efanelekileyo xa kuthelekiswa nemigangatho yangoku yeentlobo ngeentlobo zoyilo ukuze kuthintele yaye kuncitshiswe iziganeko ezingabeka esichengeni ukhuseleko. Lilonke, kufunyaniswe ukuba uyilo lweKoeberg olukhoyo lwanele xa luhlolwa luthelekiswa nesiseko selayisenisi nemigangatho yelizwe neyamazwe ngamazwe. Isiseko selayisenisi liqela lamaxwebhu, iinkqubo ezilandelwayo, nemiqathango emele ithotyelwe ye-NIL-01 ekhutshwe yiNNR.

Uyilo lwesitishi saseKoeberg luye lwaphuculwa ngokuhamba kweminyaka ngokuthi kucingelwe iteknoloji ephuculweyo, amava okusebenza eli lizwe nawamazwe ngamazwe (izinto ezifundiweyo), kunye nemigangatho yakutshanje yokhuseleko. Utshintsho olwenzelwe ukuphucula ukhuseleko nokuthembeka kweKoeberg luquka ukutshintsha iitanki ezigcina amanzi okutshintsha amafutha, ukutshintsha iintloko, Ukutshintshwa kwezixhobo zokuvelisa umphunga, zemiphanda weeriyektha (reactor vessel heads), ukutshintsha isistimu yokhuseleko nesistimu yolawulo lwe-turbine, ukutshintsha isistimu ye-reactivity control rod, ukuphuculwa kwesistimu yokubeka esweni i-radioactivity, ukuphuculwa kwesistimu yokupholisa yedama lamafutha asetyenzisiweyo, nezinye ezininzi. Zonke izinto eziphambili ezitshintshiweyo eKoeberg zigqityiwe, Emva kwengozi eyenzeka eFukushima eJapan ngo-2011, iKoeberg yenze uhlolo lokhuseleko ngokokuyalelwa yiNNR. Uhlolo lokhuseleko belujoliswe kwiziganeko eziqatha ezenzeka ngaphandle (ezifana neenyikima neetsunami) ezinokuchaphazela kakhulu ukusebenza ngendlela ekhuselekileyo kunye nokulungela nokusabela kwimeko yongxamiseko. Kufunyenwe izinto eziliqela ezifuna ukutshintshwa nokuphuculwa ukuze kwenziwe izinto ezifundwe kwingozi yaseFukushima (njengoko ixoxiwe kwicandelo 8.1 naku-10.1.3). IKoeberg sele iyiphucule intsabelo kwiziganeko eziqatha ezenzeka ngaphandle, ngokuba nemithombo ehambayo engakumbi yombane neminye imithombo yamanzi okupholisa kwidama lamafutha asetyenzisiweyo kunye nokuphuculwa kweentonga zokutywina impompo ye-reactor. Ukuphucula kuyaqhubeka nezinye izinto nokongeza umthombo wamanzi anokumelana nenyikima enkulu. Ezi zinto zenzelwa ukuphucula ukhuseleko lweziko, nokuze senze izinto esizibophelele ngazo kwiNNR.

Umgangatho ophezulu wokhuseleko uyafikelelwa ngenxa yemiqobo emithathu eseKoeberg evalela imathiriyali eneradiyeyishini. Umqobo wokuqala ziityhubhu zamafutha enyukliya

ezenziwe ngeemathiriyali zodidi oluphezulu ukuze zimelane namaqondo obushushu noxinzelelo oluphezulu. Umqobo wesibini yisistimu yokupholisa iriyektha eyilwe ngohlobo lokuba idlulisele ubushushu obuvela kumafutha enyukliya kwiisistimu ezingezantsi ukuze zidale ulophu oluza kuqhuba ii-*turbine*. Isistimu yokupholisa iriyektha iyakwazi ukulawula ubushushu, uxinzelelo, nentsabelo yenyukliya. Umqobo wesithathu sisakhiwo esigqumileyo, ekuhlala kuso isistimu yokupholisa iriyektha. Siyilwe saza sakhiwa sanenwebu yentsimbi nomaleko ongaphandle wekhonkrithi oqiniswe ngeentsimbi.

Umda wokhuseleko ungachazwa njengomnyinge ekungadlulwa ngawo kumda oqhelekileyo wokusebenza ngaphambi kokuba kubekho ukusilela. Izitishi zombane wenyukliya ezifana neKoeberg ziyilwe zanemida ebanzi yokusilela ukuze kuncitshiswe umngcipheko okanye ubuqatha bengozi yenyukliya. Imida yokhuseleko ifunyanwa ngokusebenzisa iimathiriyali eziqinisekisiweyo neekhowudi zoyilo, ngokuvavanya iikhomponenti, nangokwenza uqikelelo oluqhotyoshiweyo. Uyilo lweesistimu zokhuseleko lwaseKoeberg luhlangabezana nokusilela okungenzeka kwekhomponenti yesitishi ebalulekileyo kukhuseleko ngaphandle kokuphumela ekubeni isistimu eyenzelwe ukhuseleko ilahleke (nto leyo eyaziwa ngokuba kukusilela kwento enye).

Uyilo lwaseKoeberg luhlangabezana nophinda-phindo (redundancy) kunye nokwahluka kwesistimu zokhuseleko ngokuquka uphindo-kabini (duplicate) oluzimeleyo lwesistimu nganye eyaziwa ngokuba nguTrain A noTrain B kwiyunithi nganye (uphinda-phindo). Kuneesistimu zemeko kaxakeka eziyilwe ngendlela eyahlukileyo njengeesistimu ezifaka amanzi eziqhutywa ziinjini ezisebenza ngombane kunye neesistimu ezifaka amanzi eziqhutywa yi-turbine yomphunga (ukwahluka). Ukwahluka kukhusela ekusileleni kwazo zonke iisistimu kuba zifana.

I-PSR igqibe ekubeni uyilo lwesi sitishi lusekelwe kwimigaqo yokhuseleko ebanzi ubukhulu becala ehambisana noqheliselo olululo nolusebenzayo. Izakhiwo, iinkqubo, namanyathelo alandelwayo ukuze kuyilwe isitishi agqalwa njengangqingqwa ngokwaneleyo ukuze kugcinwe ukuthembeka ngokuqhubekayo kwesi sitishi ukuze kuxhaswe ukuqhubeka kweKoeberg isebenza ngendlela ekhuselekileyo.

11.2 Eyona meko zikuyo iisistimu, izakhiwo neekhomponenti

Eyona meko zikuyo iiSSC ezibalulekileyo kukhuseleko iye yahlolwa kwiPSR ukuze kuqondwe ukuba siyathotyelwa isiseko selayisenisi ekhoyo, kuthelekiswe uqheliselo lwaseKoeberg nemigangatho yakutshanje nezikhokelo zamazwe ngamazwe ezibandakanya ukulawulwa kokuguga kweeSSC, kuze kuhlolwe ukusebenza nokuthembeka ebudeni beLTO. I-PSR ifikelele kwezi zigqibo zilandelayo:

- Imigangatho noqheliselo olukhoyo lokhuseleko ngokuphathelele kwimeko yeeSSC, ukulungiswa, ukujongwa, ukuhlolwa kwazo noxa zisebenza, nokuvavanywa zihambisana neekhowudi zokhuseleko, imigangatho, noqheliselo lwelizwe nolwamazwe ngamazwe.
- Iinkqubo zokulawula ukuguga (iinkqubo zokulungisa, zokujonga, zokuhlola noxa zisebenza nezokuvavanya, njalo njalo.) zigubungela yonke into kwaye ziphunyezwa kakuhle, nto leyo eqinisekisa ukuba imisebenzi yeeSSC efunekayo yokhuseleko nebalulekileyo kukhuseleko ingenziwa ebudeni beLTO. Nangona kuphawulwe ukuba kukhona ukwanda kokusilela kweekhomponenti ngenxa yemiphumo yokuguga neyokuphelelwa, azikho iiSSC ezibalulekileyo kukhuseleko ezifuna ukuqwalaselwa ngokungqalileyo xa kuthelekiswa nokusilela okwenzeka kumazwe ngamazwe, kwaye ukusilela kuye kwasingathwa kakuhle yinkqubo yokulawula ukuguga.
- Yonke imisebenzi yokulungisa, yokujonga, yokuhlola, yokuvavanya, neyokulinganisa yenziwa kakuhle kunamathelwa ngokungqongqo kwiinkqubo, kumanyathelo amele alandelwe, nakuludwe lweenkqubo ezicetyiweyo. Xa imisebenzi ekuludwe lwenkqubo ingenziwa ngenxa yokungabikho kwee-spares okanye ukuphelelwa kwazo, kuye kwenziwa iindlela ezizezinye kwabekwa nezizathu zazo ukuze kuqinisekiswe ukuba ukhuseleko lwenyukliya aluchaphazeleki.
- Uphononongo lweengxelo ezikhoyo kungqine ukuba yonke inkcazelo ebhaliweyo iphelele kwaye iyichaza ngendlela echanileyo eyona meko yeeSSC ezibalulekileyo kukhuseleko.
- Kujoliswe ngokukhethekileyo kwiikhomponenti nakwizakhiwo ezinkulu ezingayi kutshintshwa ngeLTO ngokusekelwe kuhlolo, ekujongeni, kumava omsebenzi, nasekulungisweni ezinjengee-pressure vessel zeriyektha (iiRPV), izakhiwo ezigqumayo, izixhasi zonyikimo ezenziwe ngerabha (aseismic bearings), iibhodi zamaqhosha, neentambo zombane. Iinkcukacha ezingakumbi ngezi khomponenti zichazwe ngezantsi.
- I-RPV yenziwe phantsi kwenkqubo ebanzi yohlolo kunye nokubeka iliso kunye nohlalutyo lobunjineli olwenziwe ngumvelisi wesixhobo sokuqala. Le nkqubo kunye nohlalutyo lubonisa ukuba iRPV ilungele injongo yayo ngalo lonke ixesha le-LTO kumaCandelo omabini. Oku kuxhomekeke ekuqhubekeni nokuphunyezwa kohlolo oluthe rhoqo kwaye kwimeko yeyunithi 2 yeRPV, ukuphumeza amanyathelo ongezelelweyo olawulo lokuguga ngexesha le-LTO. Uhlalutyo lwe-RPV olufunekayo ukuze lugqitywe phambi kwe-LTO lugqityiwe, kwaye iNgxelo yoHlalutyo loKhuseleko ihlaziywa ngokufanelekileyo. Uvavanyo kunye nokubeka

iliso kwi-RPV kuya kuqhubeka kuyo yonke i-LTO ngokuhambelana neemfuno zolawulo.Izakhiwo zokugquma zihlolwa zize zilungiswe ngokuqhubekayo.

- Kutshanje, uvavanyo oludityanisiweyo olujonga umthamo wokuvuza olwenziwa qho kwiminyaka eyi-10 (ILRT) noluqhutywe ngo-2015 lungqinile ukuba akukho kuvuza kwaye izakhiwo zokugquma ziseluqilima. Uhlalutyo lobunjineli lubonisa ukuba izakhiwo ziza kuqhubeka ziluqilima ebudeni balo lonke ixesha leLTO. Ukulungiswa nokutshintshwa ngokuqhubekayo okufana nokwe-*impressed current cathodic protection* (ICCP) kuza kuqinisekisa ukuba esi sakhiwo sihlala ixesha elide kuze kunciphisa ubuqatha bokusingqongileyo kwaselwandle. Okunye ukuvavanya nokuhlola, nenye iILRT, ziye zacwangciselwa ixesha leLTO ukuqwalasela ubume bezakhiwo zokukhusela. I-ILRT elandelayo icwangciselwe iYunithi 1 ekungasebenziyo 127 kunye neYunithi 2 ekungasebenziyo 227.
- Izakhiwo zesiqithi senyukliya zixhaswa zizixhasi zonyikimo ezenziwe ngerabha, ezenza iKoeberg ikwazi ukumelana nokunyikima komhlaba ngokunciphisa amandla okudlikidleka kwezakhiwo okubangelwa ziinyikima. Ezi zizixhasi zonyikimo ezenziwe ngerabha zijongwa yinkqubo yokubeka esweni equka nokuvavanya, ukuze kujongwe iimpawu zokuguga. Izixhasi zonyikimo zikwimo encomekayo kwaye zilifanele iphulo eliqhubekayo lokuqinisekisa ukhuseleko ngexesha leLTO. Izixhasi zona zikwimo entle encomekayo, zilungile ukuba zingaqhuba zisebenza zisenza ukhuseleko ngexesha leLTO. Ukubeka esweni nokuhlola izixhasi zonyikimo ezenziwe ngerabha kuza kuqhutywa ebudeni balo lonke ixesha leLTO ukuqinisekisa ukuba lonke ushokoxeko nomonakalo luyabhaqeka ze kuthathwe amanyathelo okulungisa.
- Ukutshintshwa kweebhodi zamaqhosha akulindelekanga ngenxa yokuthembeka kwazo ngoku nokufumaneka kwee-spare parts zazo. Uvavanyo oluqhutywayo ngamaxesha athile lweebhodi zamaqhosha lusenza sizithembe ezi bhodi zamaqhosha ukuba ziza kusebenziseka ngexesha leLTO.
- Akulindelekanga ukuba zitshintshwe kakhulu iintambo zombane kwiLTO ngenxa yokuthembeka kwazo ngoku, imeko yazo, namava afunyenwe kwizitishi zombane. Uhlalutyo lobunjineli lufumanise ukuba iintambo zombane ezikwaziyo ukumelana neemeko eziqatha (ubushushu, ukufuma neradiyeshini) zingakwazi ukusetyenziswa ngexesha lonke leLTO. Ukuvavanya ngakumbi kucwangcisiwe ngexesha leLTO ngelokuqwalasela ubume beentambo.

- Njengoko bekutshiwo ngaphambili kolu xwebhu, kucetywa ukutshintsha iinjini zomphunga. Iinjini zomphunga ezindala zithanda ukuguga ngokuthi kuchachambe iityhubhu. Le nto ilawulwa ngokuthi zihlolwe kwaye kungcitywe ezo tyhubhu. Kodwa ke, ukuze kuqinisekiswe ukuba ukhuseleko nokuthembeka kuqhubeka kukho lonke ixesha leLTO, kufakwa iinjini zomphunga ezintsha ezingayi kuba naso esi siphako.
- Uphononongo lwePSR lugqibe ekubeni akukho zithintelo zinkulu kwiLTO ezidibene noyilo lwesitishi okanye ne meko ezikuyo iiSSC ezibalulekileyo kukhuseleko, ukuba nje ziza kulungiswa kwangethuba izinto eziboniweyo ezitenxileyo ngokuhambisana neSicwangciso Sokuphumeza Esityanisiweyo SePSR.

11.3 Uhlolo Lolawulo Lokuguga LweSALTO

Uqheliselo neenkqubo ezisebenzayo zokulawula ukuguga zingayithintela imiphumo emibi ingachaphazeli ukuthembeka kweeSSC ebudeni bexesha leLTO. Uhlolo lolawulo lokuguga lweSALTO lwenziwe liqela leengcali zeli lizwe nezamazwe ngamazwe. Belujoliswe ekuboneni ukuphelela koqheliselo neenkqubo zokulawula ukuguga ezikhoyo eKoeberg kusetyenziswa izinto ezifunwa kukhuseleko kumazwe ngamazwe, kweli lizwe, nakwimiyalelo. Uhlolo lweSALTO luqinisekisa abolawulo lwezixhobo ezigugayo ngokhuseleko oluzinzileyo lweLTO.

Uhlobo nomlinganiselo wemiphumelao emibi yokuguga zixhomekeka kwizinto ezifana noyilo, imeko yemathiriyali, ukwakhiwa, indlela yokusebenza, nokusingqongileyo osebenza kuko loo matshini. Ukuqonda ngokupheleleyo indlela iiSSC eziguga ngayo ngokuhamba kwexesha nefuthe lokuguga ekuthembekeni kweeSSC ukuba zenze umsebenzi wazo kubalulekile ukuze kuphuhliswe inkqubo yokulawula ukuguga elungeleleneyo. Ngoko, ukuhlolwa kokulawulwa kokuguga kuqala ngokufumana zonke iisistimu, izakhiwo, neekhomponenti (SSCs) zesitishi ezibalulekileyo kukhuseleko lwenyukliya (ezinjengee-pressure vessels zeriyektha, iikhomponenti zesistimu eyintloko, nemibhobho yoxinzelelo oluphezulu). Ingqalelo ekhethekileyo inikelwa kwizakhiwo neekhomponenti ekunzima ukuzitshintsha; uyilo, eyona meko zikuyo, neenkqubo zazo zokulawula ukuguga ziyaqinisekiswa ukuze kuqinisekiswe ukuba zisebenza ngendlela enokuthenjwa lonke ixesha leLTO.

Uvimba wenkcazelo wawo onke amava okusebenza aphathelele ukuguga kwezixhobo zesitishi senyukliya, ezifana nezixhobo ezisetyenziswa eKoeberg, uyafumaneka kwaye angasetyenziswa kunye namava eKoeberg ngokwayo aphathelele ukuguga kwezixhobo. Lo vimba wenkcazelo ofumaneka kwiKoeberg omalunga nokuguga kwezixhobo ufunyenwe kumava aphathelele ukuguga e-EDF nakwiAIAEA International

Generic Ageing Lessons Learned (IGALL). Unikela ngenkcazelo eninzi ngoqheliselo olungqinwe lusebenza lokulawula ukuguga nangokulungela iLTO. Ngoko izinto ezidibene nokuguga zaziwa kakuhle kwaye ziyaqondwa. Le nkcazelo isetyenziswa kwiinkqubo nakwiinkqubo zokuguga ezisetyenziswa eKoeberg ukuze izinto ezidibene nokuguga zibonwe, zithintelwe, zibhangiswe, okanye zilawule ngokuqhubeka zibekwe esweni.

Isikhokelo esilawula uLawulo Lokuguga Nokwandiswa Kwexesha Lokusebenza Kwezitishi Zokuphehla Umbane Wenyukliya [12] sichaza ekufuneka kwenziwe ukuze kuqinisekiswe ukuba iinkqubo zokulawula ukuguga ziyasebenza. Izinto ezenziwayo ukuze kulawulwe ukuguga eKoeberg zihambisana nezinto sisikhokelo esilawulayo [12] kwaye ziquka ezi zinto zilandelayo:

- Ukuhlola ukwanela nokusebenza kweenkqubo zokulawula ukuguga zaseKoeberg zithelekiswa neempawu ezingqalileyo ezichazwe ku- [12]
- Uthelekiso lweenkqubo zokulawula ukuguga novimba wolwazi okwi-IAEA IGALL osebenzayo
- Ukukhangelwa kweeSSC ezinexesha elifutshane lokusebenza nokuqinisekiswa kwexesha lazo eliseleyo ukuze kusetyenzwe ngendlela ekhuselekileyo. Olu luhlalutyo lokhuseleko olujongana neziphumo zokuguga ngokusekelwe kwixesha okanye kubude bexesha zisebenza kwaye lubizwa ngokuba luhlalutyo lokuguga olusikelwe ixesha (time-limited ageing analysis [iiTLAA]).
- Ukuhlolwa kokuzinza kweenkqubo zenkqubo yokulawula ukuguga ezinjengeenkqubo zokuthembeka kwezixhobo, uvimba wenkcazelo yokulawula ukuguga, inkqubo yokuphelelwa kweteknoloji, njalo njalo.
- Ukuhlolwa kokufaneleka kweenkqubo zokutshintsha isitishi ezifunekayo ukuze kuhlolwe imiphumo yokuguga njengokuhlola ukuba iikhomponenti ekutshintshwa ngazo zingakwazi ukumelana nemiphumo yokuguga, ukuphelelwa, neenkqubo zokulawula ukuguga.
- Ukufumana nokuphumeza amanyathelo okuphucula ngexesha elililo elibekiweyo ukuze kulungiswe izinto ezifunyaniswe ebudeni bohlolo lweSALTO

IKoeberg igqibile ukuhlola ulawulo lokuguga, yawabona namanyathelo (imisebenzi yokuphuhlisa) adingekayo kwiLTO. Lo msebenzi ngoku zigqitywe ngempumelelo, zizalisekisa zonke iimfuno ukuze uxhase iLTO ekhuselekileyo. IKoeberg yamema neIAEA ukuza kwenza iphulo leSALTO lokuhlaziya ubume bemisebenzi yeLTO kusetyenziswa imiqathango yeIAEA nempumelelo yamazwe ngamazwe. Iziphumo zephulo leSALTO ziza kuxoxwa kwicandelo elilandelayo.

11.4 Ingxelo ngephulo leSALTO

I-IAEA iqhube umsebenzi weSALTO eKoeberg ngoMatshi 2022. Eli qela lihlaziye imisebenzi egqityiweyo, eqhubekayo necwangcisiweyo enxulumene ne-LTO, kubandakanya nokulawulwa kokuguga kwee-SSC ezibalulekileyo kukhuseleko kunye nokuhlaziywa kwee-TLAAs. Ngokusebenzisa uphononongo, iqela le-IAEA laphawula ukuba “isiphehli sijongane nokuphambuka okubalulekileyo kwimisebenzi yolawulo lokuguga kunye nokulungiselela i-LTO ekhuselekileyo ukusukela kwimishini yangaphambi kwe-SALTO ngo-2019” [38]. Iqela lokuhlola lavuma ukuba eminye imisebenzi isekhona kwaye yachaza iindawo ekufuneka ziphuculwe ukuze kufezekiswe ukuhambelana nemigangatho yokhuseleko ye-IAEA ye-LTO ekhuselekileyo.

Iindaba ezilishumi elinesine (izindululo ezilishumi elinesibini kunye neengcebiso ezimbini) zabonwa yi-IAEA kwimishini yeSALTO ngo-2022. Imiba ebonakalisiweyo yayingengomcimbi wokhuselo lwenyukliya kodwa ingcebiso yokuphucula ukulungiselela iLTO. Iqela elilandelayo le-SALTO eliqhutywa ngowama-2024 liqinisekisile inkqubela entle ekujonganeni nemiba echongiweyo ngowama-2022. Kwimiba elishumi elinesine ehlaziyiweyo, ishumi elinesibini lisonjululwe ngokupheleleyo kwaye ezimbini zibonise inkqubela eyanelisayo. Ukususela ngoMeyi ka-2025, imiba ebikade ibonisa inkqubela eyonelisayo, oko kukuthi, ukuphunyezwa kweenkqubo zenkxaso ye-LTO kunye nokubuyiselwa kokusebenza kwenkqubo yokubeka esweni ukuvalelwa kuye kwaqwalaselwa. Nangona kunjalo, ukuphunyezwa kolungelelwaniso lokulandela umkhondo kwi-intanethi kuya kugqitywa ngexesha le-LTO, oku kuya kuqinisekisa ukuba izakhiwo zokubamba zinesixhobo sokubeka esweni ixesha lokwenyani esiya kuqinisekisa ukuphuculwa kolawulo lokuguga kwesakhiwo. Iqela lokuhlola ligqibe kwelokuba amanyathelo athatyathwayo ukusombulula le miba ayasebenza kwaye akhokelela kuphuculo olubonakalayo [39].

11.5 Uhlolo lokhuseleko lwamaxesha athile

Ilayisenisi yeNNR ifuna ukuba kwenziwe iPSR qho emva kweminyaka eyi-10. Ijoliswe ekuhloleni nasekubekeni imilinganiselo ngokupheleleyo uyilo, amaxwebhu, iisistimu zolawulo, iinkqubo ezisungulweyo, iinkqubo, namanyathelo alandelwayo kwesi sitishi sombane wenyukliya kuthelekiswa nemigangatho yokhuseleko ekhoyo elizweni nakumazwe ngamazwe kunye noqheliselo lokusebenza ukuze kubonwe ukhuseleko olupheleleyo lwesitishi sombane wenyukliya kwaye kuqinisekiswe ukuba sikhuselekile ukuba siqhubeke sisebenza. Esinye seziphumo zePSR kukubona uphuculo lokhuseleko olungenziwa ngaphambi kwePSR elandelayo ukuze kuqhutyekwe kuphuculwa ukhuseleko lwesitishi sombane wenyukliya.

I-PSR yokuqala yaphumela ekusungulweni ngokubanzi kweenkqubo zolawulo zesitishi, uqheliselo lolawulo kunye nokuphunyezwa kotshintsho lokhuseleko lwesitishi olwalwenzelwe ukuphucula ukhuseleko lwenyukliya yesakhiwo ukuze kunyuswe umkhamo wokukhuselwa kukawonke-wonke nabasebenzi. Isigqibo sePSR yokuqala sakhokela ekubeni iNNR yamkele ingxelo yokuhlalutya ukhuseleko yokugqibela kuze kuphuculwe kakhulu ukhuseleko kuyilo lwaseKoeberg.

I-PSR yesibini yaseKoeberg ibijoliswe ekuthelekiseni iinkalo eziphambili zoyilo lwesi sitishi noqheliselo lokusebenza kunye nolwezitishi zombane ezifana nesi ezibhexeshwa yinkampani yombane yaseFransi, iEDF. Ngaphandle kokuphuculwa kokhuseleko lwesitishi, ezinye iziphumo eziphambili zePSR beziquka ukwenziwa kophononongo olungakumbi lokhuseleko, ukuhlaziywa ngokupheleleyo koqheliselo lokulawula ukuguga kwesi sitishi nemfuneko yokuhlola ngokutsha uphononongo lwesiza olwalusetyenziswe ekuqaleni ukuze kuyilwe iKoeberg ngaphambi kokuba sakhiwe esi sitishi.

Emva kwengozi yaseFukushima eyenzeka eJapan, iKoeberg yahlola ngokutsha ukhuseleko ijolise kwiziganeko ezingaphandle eziqatha (njengeenyikima neetsunami) ezingaba nefuthe elibi ekusebenzeni ngokhuseleko nokulungela imeko yongxamiseko nentsabelo ukuze kuhlangatyezwane nezo ziganeko zinamathuba amancinci okwenzeka kodwa ezingaba nemiphumo emikhulu. Kuye kwaphuculwa izinto eziliqela ngenxa yolu hlolo, kwaye kusacetywa uphuculo olungakumbi.

I-PSR yesithathu eyenzelwe ukuxhasa iLTO ihlole izinto ezifunekayo ezingaphezu kwe-1150 zithelekiswa nezinto ezijongwayo kwimigangatho ekhoyo yelizwe neyamazwe

ngamazwe. Le nto yenziwe kusetyenziswana neengcali zeli nezamazwe ngamazwe kuquka nenkxaso yobugcisa evela kwi-IAEA. Kufikelelwe kwezi zigqibo zibalulekileyo zilandelayo kwiPSR yesithathu:

- Uyilo olukhoyo ngoku kwesi sitishi lwanele xa luhlolwa luthelekiswa nesiseko selayisenisi kunye nemigangatho yelizwe neyamazwe ngamazwe. Iinkqubo namanyathelo alandelwayo kuyilo lwesi sitishi zingqingqwa ngokwaneleyo ukuze zigcine ukuthembeka koyilo lwesi sitishi nokhuseleko.
- Iinkqubo ezidibene nokulungiswa kwemeko yeeSSC zanele kwaye ziphunyezwa kakuhle. Eyona meko yeeSSC ezibalulekileyo kukhuseleko isenza sithembe ukuba ziza kuyenza imisebenzi yazo yokhuseleko de kufike iPSR elandelayo, kuquka neLTO.
- Iinkqubo zokufaneleka kwezixhobo zihambelana nemigangatho yamazwe ngamazwe kwaye ziza kukwazi ukuqinisekisa ukuba kukho izixhobo ezifanelekileyo ebudeni bayo yonke iLTO.
- Iinkqubo, neendlela zokulawula ukuguga ubukhulu becala ziyafikelelwa, kwaye iLTO ingenziwa xa kunokuphuculwa izinto ezicetyisiweyo.
- Uhlalutyo lokhuseleko kwiimeko ezingenakuphepheka lugqibe ekubeni akho amanyathelo aneleyo alungiselela izinto ezingemanga ngendlela ezichaphazela uhlalutyo lokhuseleko kwiimeko ezingenakuphepheka. Injongo yohlalutyo lokhuseleko kwiimeko ezingenakuphepheka kukungqina ukuba imisebenzi yokhuseleko ingakwazi ukwenziwa.
- Zizonke iziphumo zohlolo lokhuseleko kwizinto ezinokwenzeka zingaphantsi kwemida ebekwe yimiyalelo echazwe kwi-RD-0024 (izinto ezifunekayo kuhlolo lomngcipheko nasekuthotyelweni kwezinto ezibalulekileyo ezijongwayo kukhuseleko) ukwenzela incopho neavareji yomngcipheko kuluntu.
- Iingozi (ezangaphakathi nezangaphandle) ziyaqondwa, kwaye kukho iindlela zokuzinciphisa ezo ngozi.
- Indlela oluqhuba ngayo lulonke nje ukhuseleko lwenyukliya eKoeberg ikumgangatho owamkelekileyo.
- IKoeberg izifikelela ngokwaneleyo zonke izinto ezidityanisiweyo ezifunekayo ezinento yokwenza nokusetyenziswa kwamava (izinto ezifundiweyo) avela

kwezinye izitishi nafunyaniswe kuphando. Uhlolisiso lugqibe ekubeni azikho iindawo ezingasingela phantsi ukhuseleko lwenyukliya okanye iLTO.

- Inkqubo yolawulo edityanisiweyo ehambisana nemigangatho yamazwe ngamazwe iye yaphunyeza equka inkqubo epheleleyo yokuqinisekisa ngomgangatho ophezulu.
- Amanyathelo alandelwayo kulawulo nakwinqanaba lokusebenza ubukhulu becala anexesha ekho kwaye ayasebenza. Yonke imiqathango yeNNR edibene namanyathelo alandelwayo iyalungiswa kuze kuhlangatyezwane nazo. Olu xwebhu luhlangabezana ngokupheleleyo nemigangatho yeIAEA neyoMbutho Wabalawuli Benyukliya ENtshona Yurophu (Western European Nuclear Regulators Association [WENRA]).
- Iinkqubo namanyathelo alandelwayo kwezabasebenzi zibhalwe kakuhle kwaye zihambelana nemigangatho yamazwe ngamazwe. Isicwangciso sabasebenzi sikho kwaye silungiselela ukuba kubekho abasebenzi abaneleyo ukuze kusetyenzwe ngokukhuselekileyo neLTO.
- Ucwangciso lwemeko yongxamiseko (emergency plan [EP]) namalungiselelo entsabelo zanele kwaye zibhalwe ngendlela efanelekileyo ukuze kuqinisekiswe ukuba kuyaqhutyekwa kusetyenzwa ngendlela ekhuselekileyo kwesi sitishi, ngoku nasebudeni beLTO.
- Ifuthe lesi sitishi kokusingqongileyo alingako xa kuthelekiswa neminye imithombo yeradiyeyishini, kwaye kukho amanyathelo athathwayo ukuze kulawulwe inkcitho. Ifuthe kokusingqongileyo lifanelekile kwaye liyakufikelela oko kulindelekileyo.
- Izinto ekuqhutywa kakuhle kuzo ziza nobungqina bokuba ikho imizekelo yokuqhuba ngendlela esemagqabini kwenkampani. Ngokomzekelo, ukuqhuba kakuhle kumba wamava okusebenza amazwe ngamazwe kungaxhasa ukuqhubeka kweKoeberg isebenza ngendlela ekhuselekileyo, kuquka iLTO.
- Ngokusekelwe kwifuthe lomngcipheko owandayo odalwa zizikhewu ezibonwe ebudeni bohlolo, aboniwe amanyathelo afanelekileyo okuphucula amele athathwe, kwaye amaxesha asikelwe wona agqalwa njengafanelekileyo nahambisana nefuthe lawo kukhuseleko.

Zimbini iintlobo zezikhewu eziboniweyo. Okokuqala, izikhewu ezidibene nemisebenzi ekufuneka zigqitywe ngaphambi kokuba kungenwe kwiLTO, njengokuhlaziya iinkqubo zokulawula ukuguga kwezixhobo. Ezi ngxaki sele zilungisiwe kwaye ngoku zigqityiwe (isahluko15). Okwesibini, bekukho izikhewu ebekufuneka zivalwe ngaphambi kwePSR elandelayo. Amanyathelo okuphucula alungisa ezi zikhewu aqukiwe kwisicwangciso esityanisiweyo sokuphucula nesithunyelwe kwiNNR ukuze sigunyaziswe, kwaye ayalandelelwa aze abekwe esweni de onke amanyathelo okuphucula agqitywe. Inkqubela-phambili yokuphumeza imisebenzi iyaxelwa kwi-NNR rhoqo emva kweenyanga ezi-6.

Emva kokuhlalutya izikhewu nezinto ekuqhutywa kakuhle kuzo nokuqwalasela ukuthathwa kwangethuba kwamanyathelo okuphucula, iPSR igqibe ekubeni kuyaxhaswa ukuqhubeka kusetyenzwa ngendlela ekhuselekileyo, kuquka iLTO.

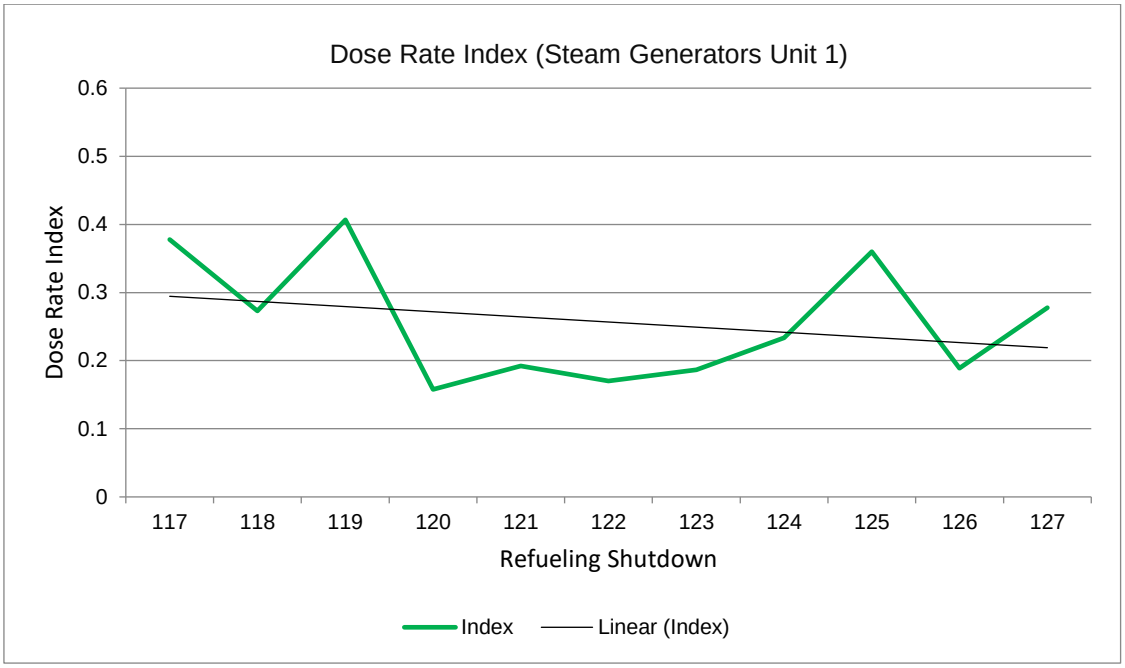
11.6 Inkqubo yokukhusela kwiradiyeyishini

Uhlolo lwenkqubo yokukhusela kwiradiyeyishini ithelekiswa nezinto ezifunwa yimiyalelo nangamazwe ngamazwe luqhutyiwe ebudeni bePSR. Olu hlolo lungqine ukuba iinkqubo namanyathelo alandelwayo ekukhuseleni kwiradiyeyishini ahambisana nezinto ezifunwa yimiyalelo nangamazwe ngamazwe. Kukho iinkqubo namanyathelo alandelwayo akhoyo ukubeka esweni nokulawula ukuphuma kwezinto ezineradiyeyishini ziye kokusingqongileyo nokuchanabeka emsebenzini. Imida yedowusi yochanabeko emsebenzini nakuluntu igqalwa njengengaphantsi kakhulu kunemida ebekwe yiNNR. (Jonga icandelo 10.2.3 necandelo 10.2.4.)

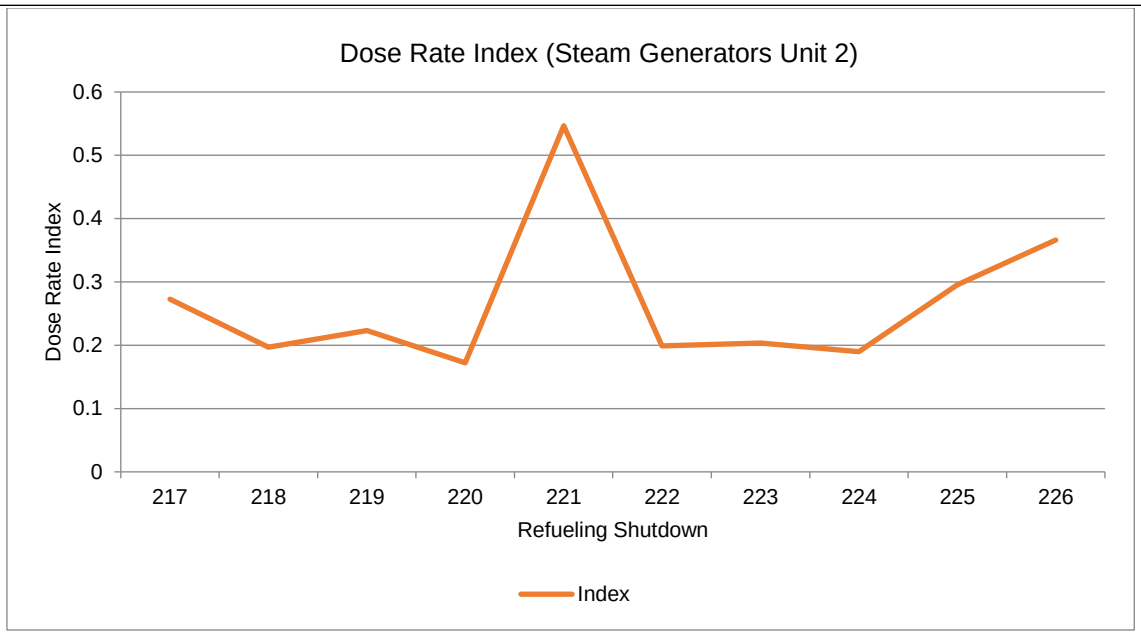
Ngaphandle kwePSR, inkqubo yokukhusela kwiradiyeyishini izuza kumava amazwe ngamazwe ngezinye izimvo ezifana namaphulo okuxhasa kubugcisa (aqhutywe ngo-2016) kunye nokuhlolwa ngoontanga (okuqhutywa ngo-2021). Iphulo lokuxhasa kubugcisa nokuhlolwa ngoontanga kuqhutywe yiWANO. Zombini ezi zimvo ziye zancoma, kwakho amanyathelo okuphucula awenzelwe ukuphucula nangakumbi inkqubo yokhuselo kwiradiyeyishini.

Inkqubo yokhuselo kwiradiyeyishini ithi makubekwe esweni qho umlinganiselo wedowusi kummandla wesitishi ukuze kubekwe esweni ukunyuka kwedowusi ngenxa yotshintsho olunjengeemeko zokusebenza zesitishi, ukudyobheka yiradiyeyishini, nokufumba kweemveliso zeradiyeyishini. Imimandla yesiza iphawulwe ngeempawu ezibhaliweyo, kwaye abantu abangenayo balawulwa ngokufanelekileyo, kuxhomekeka

kumlinganiselo wedowusi. Iindawo ezinamaqondo aphezulu edowusi ziyatshixwa okanye ziblokwe ukuze kuthintelwe abasebenzi bangangeni. Amaqondo edowusi kwimimandla elawulwayo (imimandla yesitishi apho abasebenzi bengachanabeka kwiradiyeyishini) apho abasebenzi bexhaphake khona ukuze balungise okanye basebenze ibekwa esweni ngakumbi, kwaye isicwangciso namaphulo ayaphunyezwa (njengeesistimu zokugutyula, ukuhlamba, nokukhusela) ukuze kugcinwe amaqondo edowusi ephantsi kangangoko kunokwenzeka.



Umfanekiso 19: I-indeksi yeqondo ledowusi kwiinjini zeYunithi 1



Umfanekiso 20: I-indeksi yeqondo ledowusi kwiinjini zeYunithi 2

Amaqondo edowusi alinganiswe kwimimandla yesi sitishi aye ahlala ezinzile ukutyhubela ixesha ngokusekelwe kwiziphumo zophononongo lwemimandla yesitishi. Umfanekiso 20 noUmfanekiso 19 isinika i-indeksi yamaqondo edowusi kwimimandla yeenjini zomphunga zeYunithi 1 noYunithi 2, ngokulandelelana. Le nto imela isampulu yamaqondo anyukayo okanye ehlayo edowusi, ngokukodwa kwiindawo ezineqondo eliphezulu ledowusi kwesi sitishi. Le indeksi yeqondo ledowusi kwimimandla yeenjini zophunga iye yaqhubeka imalunga no-0,2 no-0,5 kuzo zombini ezi yunithi zeriyektha ngexesha ebelihlolwa ngalo ngo-2009 (Ukuvalwa Ngenjongo Yokutshintsha Amafutha 117) nango-2025 (Ukuvalwa Ngenjongo Yokutshintsha Amafutha 127) kwiYunithi 1 nango-2009 (Ukuvalwa Ngenjongo

Yokutshintsha Amafutha 217) nango-2024 (Ukuvalwa Ngenjongo Yokutshintsha Amafutha 226) kwiYunithi 2.

Amanyathelo okunciphisa amaqondo edowusi aye aphunyezwa (njengokutofa i-zinc notshintsho kwiindlela zokusebenza), kwaye aye anceda ekunciphiseni amaqondo edowusi kwisitishi okanye awagcina ephantsi. Ekubeni ephantsi kakade amaqondo edowusi emsebenzini (jonga kwicandelo 10.2.4), kulindeleke ukuba idosi yasemsebenzini iza kuhlala ingaphantsi kakhulu kwimida ebekwa yimiyalelo ebudeni bexesha leLTO.

Inkqubo yokukhusela kwiradiyeyishini akulindelwanga ukuba itshintshe kwaye iza kuqhubeka isebenza ebudeni beLTO. Uphuculo oluqhubekayo luza kubangelwa zizimvo nohlolo oluqhubeka lusenziwa yiKoeberg, yimibutho yamazwe ngamazwe, nayiNNR. IKoeberg iza kuqhubeka iqiniseka ukuba abasebenzi abanobuchule, ii-instrumenti ezaneleyo zokubhaqa iradiyeyishini, izixhobo zokuphatha izinto ezineradiyeyishini ngendlela ekhuselekileyo, nezixhobo zokukhusela imizimba ziyafumaneka ukuze kulawulwe iingozi ezidalwa yiradiyeyishini eKoeberg.

11.7 Ukugadwa kwendawo neekhompyutha

Inkqubo yaseKoeberg yokugada indawo neekhompyutha iza kuqhubeka inciphisa ukonzakala ngenxa yazo naziphi izisongelo. Imigangatho, amanyathelo alandelwayo, neesistimu ezisebenzayo, kuquka iisistimu zokukhusela umzimba ziyaphunyezwa kwaye ziqhubeka zihlolwa zize ziphuculwe ngokusekelwe kumava omsebenzi, ukutshintsha kweemeko, uhlolo, nokhokelo lweNNR.

Iinkqubo zokhuseleko ziquka amanyathelo okukhusela iinkqubo zekhompyutha ukuze kuqinisekiswe ukuba eKoeberg akungeni mntu ungagunyaziswanga kwaye iinkqubo zayo zekhompyutha azihlaselwa.

Inkqubo yokhuseleko lwendawo nolweekhompyutha zenyukliya iyasebenza kwaye iyakuxhasa ukusetyenziswa ngokukhuselekileyo ngokuqhubekayo. I-PSR ebiqhutywa kutsha nje ifumanise ukuba ukhuseleko lweKoeberg olu-*physical* nolu-*cyber* luluqilima ngexesha leLTO. Uphicotho-zincwadi, uphononongo, nohlolo oluqhubekayo lwenkqubo yokugada indawo neekhompyutha kunye nophuculo oluza kuvela kuzo luza kuqinisekisa ukuba iqhubeka isebenza lonke ixesha leLTO.

11.8 Ukucebela nokulungiselela imo yongxamiseko

Ngokwe-NIL-01, iKoeberg kufuneka ibe nesicwangciso semo yongxamiseko ukuze kuncitshiswe imiphumo yokuphuma kweradiyeyishini xa kungenzeka ingozi. Isicwangciso esikhoyo semeko yongxamiseko sele similiselwe, sihambelana nemiqathango yolawulo ebekiweyo yeli [30] kunye neyamazwe ngamazwe, kwaye isitishi siyaziqhelanisa naso qho ngonyaka, ikhona iNNR. Amanyathelo okuphucula ayabonwa aze aphunyezwe ukuze kuqinisekiswe ukuba amalungiselelo okulungela nokusabela kwisicwangciso semeko yongxamiseko ayasebenza.

Into ejongwayo ukuze kuthathwe amanyathelo okukhusela igqityiwe yaza yabekwa kusengaphambili. Imimandla yokucebela imo yongxamiseko ibhaliwe kuso sonke isiza saseKoeberg, imela iindawo ezingachatshazelwa kukuphuma kweradiyeyishini xa kunokwenzeka ingozi. Amanyathelo okukhusela afana nokubalekisa abantu, ukubafaka ekhusini, ukubloka ithyroid, ukufudusa abantu ayaphunyezwa ukuze kuncitshiswe ifuthe kuluntu elibangelwa kukuchanabeka kwiradiyeyishini, ukusezela iradiyeyishini esemoyeni, nokuginya ukutya okungcoliswe yiyo.

Iiradiyasi yemimandla zokucebela imeko yongxamiseko yaseKoeberg zichazwe kwi-*Integrated Koeberg Nuclear Emergency Plan* ngolu hlobo:

- Ummandla wenyathelo lokuthintela [precautionary action zone (PAZ)]: lo mmandla usuka kumda wesiza saseKoeberg uye kumgama omalunga oziikhilomitha ezi-5 ukusuka kwiiriyektha, isiphelo sawo esisemzantsi simalunga neekhilomitha eziyi-8 ukusuka kwiiriyektha.
- Ummandla wokucebela inyathelo lokukhusela ngokungxamisekileyo [urgent protective action planning zone (UPZ)]: le yindawo esuka kwiradiyasi yeekhilomitha ezimalunga ne-5 ukuya kwiikhilomitha eziyi-16 ukusuka kwiiriyektha.
- Ummandla wokucebela inyathelo lokukhusela ixesha elide [long term protective action planning zone (LPZ)]: le ndawo isuka kwiradiyasi yeekhilomitha ezimalunga ne-16 iye kwiikhilomitha eziyi-80 ukusuka kwiiriyektha.

I-PAZ yindawo apho amanyathelo athile okukhusela ethathwa ngoko nangoko xa kubhengezwe imeko yongxamiseko eqhelekileyo. Eyona nto siyifunayo kukunciphisa kakhulu umngcipheko wemiphumo ngokuthatha amanyathelo akhuselayo ngaphambi (okanye ngokukhawuleza kangangoko kunokwenzeka emva) kokuba kuphume iradiyeyishini iye kokusingqongileyo. I-UPZ yindawo apho kwenziwe amalungiselelo okunika abantu ikhusi *esizeni*, kubekwe esweni kokusingqongileyo kwaye kuthathwe amanyathelo okukhusela asekelwe kwiziphumo zokubeka esweni kwisithuba seeyure ezimbalwa emva kokuba kuphume iradiyeyishini. I-LPZ yindawo ebekiweyo ejikeleze iKoeberg apho kwenziwe amalungiselelo okuphumeza amanyathelo okukhusela ukuze kuncitshiswe imiphumo yexesha elide kuluntu, oko kukuthi, kuncitshiswe imiphumo engenzeka. Ngokuqhelekileyo la ngamanyathelo okukhusela exesha elide anjengokuthintela ukutyiwa kokutya okulinywe ekuhlaleni kwiindawo ezithile ekusenokwenzeka ukuba zichaphazelekile.

Izivumelwano ezifanelekileyo zenziwe nabasemagunyeni basekuhlaleni, bephondo, abelizwe nemibutho yamazwe ngamazwe ukuze kuqinisekiswe ukuba ukulungela nokusabela kwimo yongxamiseko kuyasebenza. IKoeberg yenze amalungiselelo okufumana uncedo ebudeni bemo yongxamiseko kwiEDF, kuFramatome, kwiWANO/INPO, nakwi-IAEA. Amalungiselelo neembopheleleko zombutho ngamnye abhalwe kwisicwangciso esidityanisiweyo yemo yongxamiseko yaseKoeberg.

IKoeberg ineziko lokulawula imo yongxamiseko, iziko lokuxhasa ubugcisa, neziko lokuxhasa umsebenzi afana nesazulu (base) apho amaqela emo yongxamiseko enokunikela ngenkxaso yobugcisa, yokusebenza, neyothutho ekhona ukuze alawule imo yongxamiseko. Anezixhobo ezaneleyo nezakhiwo nenkcazelo efana nenkcazelo yonxibelelwano, eyemozulu, neyesitishi kwaye akhuselekile kwiradiyeyishini. Isixeko saseKapa naso sinazo izibonelelo zikaxakeka ezinokwaleka zincedise ezeKoeberg izibonelelo.

Abasebenzi boncedo lokuqala abacebela imo yongxamiseko baqeqeshiwe kumanyathelo alandelwayo ekucebeleni imo yongxamiseko kwaye bafumana amava asebenzisekayo ebudeni bokuprekthiza isicwangciso semo yongxamiseko.

Ngokuhambisana noko kufunwa yimiyalelo yasekuhlaleni, kufuneka isicwangciso semo yongxamiseko sihlolwe, kuphicothwe ubugcisa, kwenziwe nophononongo. Isicwangciso semo yongxamiseko yaseKoeberg sizuzile kwizinto ezifundwe kwingozi yenyukliya yaseFukushima. Uhlolo lwenziwe eKoeberg emva kwengozi yaseFukushima ukuze kubonwe izinto ezingaphuculwa ekulawuleni iingozi ezibangelwe ziziganeko eziqatha (ezinjengeetsunami neenyikima), ngokolwalathiso lweNNR. Kuphuculwe izinto eziliqela kumanyathelo alandelwayo eplani yemo yongxamiseko yaseKoeberg ukuze kuphuculwe ukulungela nokusabela kweKoeberg kwimo yongxamiseko xa kwenzeke iziganeko ezinjalo (ezinjengamanyathelo amele alandelwe ngabasebenzi abangamalalela, izikhokelo zemozulu eqatha, amanyathelo okukhusela, ukuphuculwa kwamanyathelo akwinqanaba longenelelo).

Isicwangciso semo yongxamiseko siye sahlolwa ebudeni bePSR yesithathu, kwaye ubukhulu bemimandla yokucebela imo yongxamiseko buye bajongwa, kucingwa ngothotho lweengozi ezinokwenzeka nefuthe ezinokuba nalo kuluntu nokusingqongileyo. Ingqiniwe into yokuba imimandla ekhoyo ngoku yokucebela imo yongxamiseko yanele ukuze isicwangciso semo yongxamiseko sisebenze.

Ukongeze koko, iPSR ingqinile ukuba iKoeberg ineezicwangciso, abasebenzi, izakhiwo, nezixhobo ezaneleyo zokujongana nemo yongxamiseko nokuba amalungiselelo ahlengahlengiswe ngokwaneleyo nabasemagunyeni basekuhlaleni nabelizwe kwaye isitishi siyaziqhelanisa nawo rhoqo. Le nto iza kuqhubeka injalo ngexesha leLTO, noxa kuphuculwa apho kubonakala imfuneko.

12. IZIBONELELO ZENKAMPANI ZOKUSEBENZISA ISITISHI IXESHA ELONGEZELELWEYO

12.1 Inkqubo Yolawulo

I-Nuclear Operating Unit (NOU) inikwe igunya nguEskom lokuphumeza uMgaqo-nkqubo KaEskom Yenyukliya ukuze iphumeze iinjongo zenyukliya zikaEskom zokuhambisa ngokukhuluselekileyo amandla enyukliya akumgangatho wehlabathi jikelele namhlanje, ngomso nakwixesha elizayo. Izinto ezifunwa ngumgaqo-nkqubo zilawulwa ngesicwangciso sokusebenza, esihlaziywa minyaka le.

Umgaqo-nkqubo wolawulo lwenyukliya kunye nokhuseleko lwenyukliya nemanyuwali yomgangatho ziye zahlolwa zithelekiswa nezinto ezifunwa kumazwe ngamazwe ngelixa lePSR. Olu phononongo lufikelele kwisigqibo sokuba lo mgaqo-nkqubo ukhoyo kunye nenkqubo yolawulo zanele ukuba ukuze esi sitishi siqhubeke ke sisebenze nokuba lo umgaqo-nkqubo ukhoyo uyifikelele imiqathango yeNNR echazwe kwi-RD-0034 [11].

Inkqubo yolawulo idandalazisa ubume beenkampani, amanqanaba amagunya olawulo, neemfuneko amele onke amasebe akwi-NOU abambelele kuzo ukuqinisekisa ukuthobela imiyalelo kwaye ukuphumeza amanqanaba aphezulu okhuseleko lwenyukliya.

12.2 Amalungiselelo amaziko ezemali

Ukuqhubeka nokusebenzisa esi sitishi eminye iminyaka eyi-20 kuthetha ukuzibophelela ngokusemthethweni ekuqinisekeni ukuba imali iza kwanela iLTO namaxesha okuvala isitishi.

Ngamajelo akhe okwenza ingeniso, uEskom SOC Ltd uzibophelele ekwenzeni imali ifumaneke ukuze kukwazeke ukusebenzisa esi sitishi ngendlela ekhuselekileyo nenokuthenjwa ngexesha leLTO. ISigqeba esilawula uEskom siphonononga size sihlole imeko yezimali kaEskom minyaka le, size sibonelele ngemali eyimfuneko yokubhexesha

isitishi. Ngokungqinelana noMthetho Wokulawulwa Kwemali KaRhulumente (PFMA) neminye imithetho enento yokwenza nalo mba, iSigqeba esilawula uEskom siqwalasela size sigqibe ngendlela eza kufunyanwa ngayo imali yokusebenza, nokujonga imali efunekayo kwaEskom, ngamaxesha athile (jonga iMemorandum of Incorporation kaEskom Holdings SOC Ltd efumaneka kwiwebhusiza kaEskom).

Kuxhomekeka kwiPFMA (ngokukodwa icandelo 66 lePFMA) isigqeba esilawula uEskom singanyusa okanye siboleke imali ngamaxesha athile sisenzela uEskom okanye sifumane loo mali ngokuhambisana neSicwangciso Senkampani nenkqubo yokuboleka engeniswe kuMnini-sabelo (uRhulumente).

12.3 Ezengqesho

Ukuze kuqinisekiswe ukuba kukho abasebenzi abaneleyo bokuxhasa umsebenzi oqhubekayo, uEskom unenkqubo ephangaleleyo yokulawula abasebenzi ehambisana noqheliselo olululo lwamazwe ngamazwe. Kuthotho lweenkqubo namanyathelo alandelwayo kwezengqesho kukho indlela yokulawula inkqubo yengqesho eqwalasela izinto ezinjengokuthatha umhlala-phantsi, ukuyeka emsebenzini, ukuqeshwa kwabasebenzi ukuze kuqinisekiswe ukuba kukho abasebenzi abanesakhono esisiso kwiLTO.

IKoeberg iyazidla ngokuba nendima eyidlalileyo ekuphuhliseni nasekukhuliseni ubuchule obutsha kwinyukliya kule minyaka eyi-40 idluleyo. Le nkqubo iphunyezwe ngokwayama kumanqanaba engqesho aphazelu amazwe kwihlabathi jikelele, uqeqesho lwabafundi, izakhiwo zokusebenza ngesandla, abezobugcisa, neenjineli.

Uninzi loluqeqesho luye lwanempumelelo eKoeberg nakwezinye izitishi ezisehlabathini zenyukliya, kwaye uninzi lwabasebenzi abaqeqeshiweyo luyaqhubeka lufumaneka ukuze baxhase iKoeberg.

Ngelilungiselela iLTO nemfuneko yabasebenzi abangakumbi, iKoeberg isungule iphulo lokugaya abasebenzi ukuze kuvalwe izithuba, kuthathwa ngaphakathi kwaEskom nakwiimarike zangaphandle. Iikhontraktha ezinamava ziye zafunyanwa ukuze zixhase ukwanda kwexeshana komsebenzi ngenxa yeLTO.

IKoeberg iqinisekile ukuba iindlela nezicwangcoso zayo zanele ukuqinisekisa ubukho babasebenzi abanesakhono esisiso abakwaziyo ukusebenza kwixesha leLTO.

12.4 Ubuchule bokusebenza kakuhle nokunokulawula ulwazi

I-NOU inenkqubo yoqeqesho enesiqinisekiso sokuqinisekisa ukuba abasebenzi baqeqeshiwe, bahlolwa ukuba banobuchule nesakhono sokwenza imisebenzi abayinikiweyo. Kukho uqeqesho olwahlukileyo olu ngqaliselwe kwiimfaneleko ezibaluleke kakhulu kunye nemisebenzi eyahlukileyo okanye engaqhelekanga ekufuneka kuyo ubugcisa obuphezulu, ejongwa ngokukhethekileyo kwinkqubo yokuqeqesha ababhexeshi. Le nkqubo yokuqeqesha ababhexeshi evunyiweyo kumazwe ngamazwe, kwaye ihlolwa qho zizigqeba eziphetheyo zamazwe ngamazwe. Inkqubo yokuqeqesha eyenzelwe iKoeberg yaphuhliswa ngokuhambisana nezinto ezifunwa ngamazwe ngamazwe, ingakumbi indlela enobuchule elisingatha ngayo uqeqesho lwabantu iZiko Lomsebenzi Wombane Wenyukliya [Institute of Nuclear Power Operations (INPO)]

Isebe laseKoeberg loqeqesho linenkqubo yabasebenzi abasebenza ngobugcisa besandla, nobugcisa neenjineli eline zifundo ezibhalwayo nezenzwa ngesandla. Zithi zilandelwe iimviwo nohlolo olufanekileyo nolugqale kwimisebenzi yamacandelo ngamacandelo.

Inkqubo yokuqeqesha inkokheli nabaphathi beNOU ijoliswe ekuphuhliseni ubunkokeli nolawulo nokuphuhlisa ubuchule bokuphatha kumaqanaba acekethekileyo.

I-Koeberg inezilinganisi-sitishi (plant simulators) ezimbini eziphelelelyo zoqeqesho lwababhexeshi. Ababhexeshi begumbi lokulawula (control room) kunye nabaphathi beshifti abasebenzayo bafumana uqeqesho olubanzi kunye noviwo kwizilingisi-sitishi, okukhokelela kwilayisenisi yomsebenzi ekhutshwa yiNNR. Oku kulandelwa luqeqesho oluthe gqolo lokufaneleka kunye novavanyo lokuqinisekisa ukuba nobuchule obuqhubekayo.

Ukulawula ulwazi kubalulekile ukuze kuqokelelwe kwaye kugcinwe ulwazi lwenyukliya ukuze kuxhaswe ukusebenza ngendlela ekhuselekileyo, enokuthenjwa, neyongayo. Njengoko isitsho iNNR kwi-RG-0027 [12], kufuneka kuphunyezwe iinkqubo zokulawula ulwazi nokuze uEskom aqiniseke ukuba kukho ulwazi olwaneleyo ebudeni balo lonke ixesha lokusebenza kwesi sitishi. Ezi nkqubo zisaphuhliswa nangakumbi kwaye ziqhubeka zitshintsha njengoko ziphuculwa kwaye le nkqubo isandiswa kuyo yonke inkampani. Iinkqubo zokulawula ulwazi zaseKoeberg zisebenzisa indlela edityanisiweyo ekhuthazwa yi-IAEA yokukhangela, ukufumana, ukuhlola, ukuzuza, nokwabelana ngayo yonke inkcazelo yaseKoeberg (enjengoovimba benkcazelo, amaxwebhu, imgaqo-nkqubo, amanyathelo amele alandelwe, nobuchule obungekaze bubhalwe

phantsi namava omsebenzi ngamnye) [34]. Iinkqubo ezahlukeneyo zokulawula abasebenzi zaseKoeberg ezinjengokucebela abaza kungena ezihlangwini zabanye, ulawulo lweziphiwo zabantu, uqeqesho, nokufunda umsebenzi ngokubukela kumntu owaziyo ziyasetyenziswa ukuze kuxhaswe inkqubo yokulawula ulwazi yaseKoeberg. Injongo kukwenza abasebenzi bakwazi ukusebenza ngaxhathalinye bedala ulwazi olutsha nokuqinisekisa ukuba ulwazi olubalulekileyo luyafumaneka kubasebenzi abaludingayo ukuze kusetyenzwe ngendlela ekhuselekileyo nenokuthenjwa ebudeni beLTO.

12.5 Ukuziqhelisa ukhuseleko

Ngokutsho kwe-IAEA, ukuqhela ukhuseleko lwenyukliya, eyona nto iza kuqala kwinto yonke, zizinto ezinokwenza nokhuseleko lwesitishi senyukliya ngokokubaluleka kwazo.

UEskom uye wamkela imigaqo nemikhwa yokuziqhelisa ukhuseleko yeINPO. Imigaqo nemikhwa yokuqhela ukhuseleko iye yafakwa kumaxwebhu omgaqo-nkqubo kwaye isisiseko sokuhlolwa, ukuphuculwa, nokulungiswa kokhuseleko lwenyukliya eKoeberg.

Ukuze kuqinisekiswe ukuba umsebenzi waseKoeberg uqhubeka usekelwe kwimigaqo eyamkelweyo yokhuseleko, ukuqhela ukhuseleko eKoeberg kubekwa esweni qho ngonyaka nangokuthi kuhlolwe ngokwemijikelo yeminyaka emithathu. Ukongezelela koko, njengenxalenye yeembopheleleko zabaphathi, indlela oluqhuba ngayo ukhuseleko lwenyukliya ibekwa esweni ize ifakwe kwiingxelo kumanqanaba ahlukeneyo ale nkampani.

Uhlolo-zimvo lokhuseleko lwenyukliya luqhutywa qho kwaNSC emva kweminyaka emithathu, kusetyenziswa i-INPO 12-012 (Imikhwa yeNSC eyiyo) [13]. Uphononongo lwenziwa ngo- 2014, ngo-2016, nango-2019 lwaza lwafakwa kwiNNR. Imikhwa eyakhayo eyi-10 yeNSC eyiyo (ngamnye uneempawu neendlela zokwenza izinto) yahlulwe yangamacandelo aphangaleleyo amathathu (jonga Itheyibhuli 5). Xa bekuthelekiswa iziphumo zophononongo lweNSC zibonise ukuba amanqaku ayo yonke imilinganiselo aphuculwe ngexesha elisusela ku-2014 ukuya ku-2019.

Uhlolisiso lwakutshanje lwe-NSC lwenziwe ngo-2021, kunye nohlolisiso olulandelayo olwenziwe ngoMeyi 2024. Xa iziphumo sele zidityanisiwe, ziya kungeniswa kwi-NNR. Ngowama-2025, i-NNR yenze uhlolo lwenkcubeko ye-NSC kwaye ayifumananga kukungathobeli. UKoeberg uyaqhubeka nokugcina inkqubo yeNSC engumzekelo.

Ngokusekelwe kuhlolo-zimvo lweNSC, iNSC eKoeberg ikwimo eyamkelekileyo kwaye ibekwe esweni ngendlela efanelekileyo ukuze kuqhutyekwe kusetyenzwa ngendlela ekhuselekileyo kwiLTO.

Itheyibhile 5: Imikhwa eyiyo yokuqhela ukhuseleko lwenyukliya

Imikhwa eyiyo yokuqhela ukhuselekolwenyukliya (INPO 12-012)	
Ukuzibophelela komntu ngamnye kukhuseleko	Ukuthatha uxanduva ngesimo sakho (Personal Accountability) Ukuqononondisa (Questioning Attitude) Unxibelelwano olusebenzayo lokhuseleko (Effective safety communication)
Ukuzibophelela kwabaphathi kukhuseleko	Ukuhlonipha indawo yomsebenzi Iinkokeli ezithatha imilinganiselo namanyathelo okhuseleko Ukuthathwa kwezigqibo
Iinkqubo zolawulo	Imfundo engapheliyo Ukubonwa kweengxaki Imeko eyenza kukwazeke ukuveza izinto ezixhalabisayo Iinkqubo zokusebenza

13. UKULAWULWA KWENKCITHO ENERADIYEYISHINI NENDLELA YOKUVALA ISITISHI

IKoeberg ikhupha inkcitho eneradiyeyishini eyirhasi, engamanzi neqinileyo eveliswa ngenxa yendlela iKoeberg esebenza ngayo. Inkcitho eneradiyeyishini ekhutshwayo ichazwa njengenkcitho equlethe okanye engcoliswe zii-radionuclide ngomlinganiselo okanye kwimisebenzi engaphezu kwamanqanaba avunyiweyo abekwe yiNNR. Kufuneka ilawulwe ngendlela egcina abantu nokusingqongileyo bekhuselekile kwimiphumo emibi yeradiyeyishini, enokuhlala ikho ixesha elide.

Eli candelo libonisa ukuba ulawulo inkcitho ekhutshwayo lukho kwaye lwanele kwiLTO. Ikho inkqubo yemithetho yokulawulwa inkcitho ekhutshwayo, kwaye amanyathelo alandelwayo neenkqubo zokulawula inkcitho ekhutshwayo eKoeberg zihambisana

nemimiselo efunwa kukhuseleko ngamazwe ngamazwe, leli lizwe, nayimiyalelo. Ikho imali yokuvala esi sitishi. Ukugcinwa kwazo zonke iintlobo zenkcitho ekhutshwayo eneradiyeyishini eveliswa eKoeberg kwenziwa ngendlela ekhuselekileyo.

13.1 Inkqubo yemiyalelo elawula inkcitho eneradiyeyishini

EMzantsi Afrika, imisebenzi ebandakanya amandla enyukliya nenkcitho eneradiyeyishini ilawulwa phantsi koMthetho Wamandla Enyukliya 46 Wango-1999, uMthetho We-NNR (uMthetho 47 wowe-1999) [35], uMthetho Welizwe Weziko Lokulahla Inkcitho Eneradiyeyishini 53 ka-2008 [36], Umthetho Welizwe Wokulawulwa Kokusingqongileyo 107 wango-1998, neminye imithetho efanelekileyo echazwe kuMgaqo-nkqubo Welizwe Nendlela Yokulawula Inkcitho Ekhutshwayo Eneradiyeyishini [37]. Ilayisenisi yesitishi senyukliya kaEskom ibeka imimiselo engokuhanjiswa nokulahlwa kwenkcitho eneradiyeyishini.

Ngokomgaqo-nkqubo Welizwe Nendlela Yokulawula Inkcitho Ekhutshwayo Eneradiyeyishini (Strategy 37), uRhulumente WaseMzantsi Afrika unembopheleleko yokusungula izakhiwo ezifanelekileyo zokulawula inkcitho ekhutshwayo eneradiyeyishini kwinqanaba lelizwe. Ngenxa yoko, kusungulwe iKomiti Yelizwe Yokulawulwa Kwenkcitho Eneradiyeyishini ukuze ijonge ukusetyenziswa kwalo mgaqo-nkqubo ngendlela noxa iZiko Lelizwe Lokulahlwa Kwenkcitho Eneradiyeyishini (NRWDI) linikwe umsebenzi wokulawula ukulahlwa kwenkcitho eneradiyeyishini elizweni lonke. NgokoMthetho weNRWDI [36], uEskom, njengomvelisi wenkcitho eneradiyeyishini, “... unembopheleleko ngobugcisa, imali nolawulo lwenkcitho [yakhe] ngokuhambisana nemithetho yelizwe kwindawo [yakhe] naxa loo nkcitho ihanjiswa ukuya kwindawo yokulahla inkcitho egunyazisiweyo.”

Ilayisenisi yesitishi senyukliya ifuna ukuba uEskom asebenzise iinkqubo zokunciphisa nokulawula ngendlela ekhuselekileyo inkcitho ekhutshwayo eneradiyeyishini nokuba ukhuseleko loovimba benkcitho eneradiyeyishini luqinisekiswe ngexesha elilindelekileyo lokugcinwa kwayo. UMgaqo-nkqubo Wokulawulwa Kwenkcitho Eneradiyeyishini [37] ufuna abavelisi benkcitho baphuhlise izicwangciso zokulawula inkcitho ekhutshwayo esizeni eziquka onke amajelo enkcitho eneradiyeyishini esizeni ukuze bagunyaziswe nguMphathiswa Wobuncwane Namandla.

UEskom uyayithobela imithetho ebhekiselele kuEskom, kwaye le mithetho ingasentla kulindeleke ukuba iqhubeke isebenza kwiLTO.

13.2 Uhlahlelo lwenkcitho ekhutshwayo

Inkcitho ekhutshwayo eneradiyeyishini ingahlahlelwa ukwenzela iinjongo ezahlukeneyo, kwaye iindlela zokuhlahlela ezahlukileyo zingasetyenziswa kumanyathelo alandelanayo okulawula inkcitho ekhutshwayo. EMzantsi Afrika, uMgaqo-nkqubo Wokulawulwa Kwenkcitho Eneradiyeyishini [37] ihlahlela inkcitho ekhutshwayo eneradiyeyishini ngala macandelo aboniswe kwiTheyibhuli 6.

Itheyibhile 6: Uhlahlelo lwenkcitho ekhutshwayo

Ukuhlelwa	Inkcazo
Inkcitho ekhutshwayo ekwinqanaba eliphezulu (HLW)	Inkcitho ekhutshwayo eneradiyeyishini evelisa ubushushu enee-radionuclide ezininzi ezihlala ixesha elide nelifutshane, ngokomzekelo, amafutha asetyenzisiweyo
Inkcitho ekhutshwayo ekwinqanaba eliphantsi neliphakathi - yexesha elide (LILW-LL)	Inkcitho ekhutshwayo eneradiyeyishini enee-radionuclide eziphantsi naphakathi ehlala ixesha elide nenee-radionuclide eziphakathi ezihlala ixesha elide, ngokomzekelo, inkcitho evela xa kusetyenziswa amafutha enjengeetyhubhu zamafutha. Ezi ntlobo zineziqingatha zobomi ezide.
Inkcitho ekhutshwayo ekwinqanaba eliphantsi neliphakathi - yexesha elifutshane (LILW-SL)	Inkcitho ekhutshwayo eneradiyeyishini enee-radionuclide eziphantsi okanye eziphakathi/okanye ene-radionuclide ezihlala ixesha elide, ngokomzekelo, izinto ezidyobhekileyo ezifana nezixhobo zokusebenza xa kulungiswa, amalaphu okucoca, njalo njalo. Ezi ubukhulu becala zineziqingatha zobomi ezifutshane
Inkcitho ekhutshwayo ekwinqanaba eliphantsi kakhulu (VLLW)	Inkcitho ekhutshwayo eneradiyeyishini encinane kakhulu, ngokomzekelo, izinto ezidyojwe yiradiyeyishini okanye ezinayo kancinane
NORM-L	Inkcitho ekhutshwayo ekungenzeka kwaye nayo iradiyeyishini encinane ezivelela ngendalo (naturally occurring radioactive material [NORM])
NORM-E	Inkcitho ekhutshwayo eneradiyeyishini yeNORM enochatha

Uyilo lwezakhiwo zokugcina luxhomekeka kuhlobo lwenkcitho eneradiyeyishini, iimpawu zayo kunye neengozi ezibandakanyekileyo, ubungakanani, nexesha ekulindeleke ukuba zihlale elugcinweni ngalo. EKoeberg, kukho iinkqubo ezilandelwayo ukuze kuqinisekiswe ngokuchazwa, ukubalwa, iimpawu, nokuhlahlelwa kwayo yonke

Inkcitho ekhutshwayo eneradiyeyishini eveliswayo. Ezi nkqubo zilandelwayo zichaza amanyathelo afunekayo ukuze isuswe ngokukhuselekileyo, ikhutshwe, ilahlwe, ithuthwe, kwaye igcinwe Inkcitho ekhutshwayo eneradiyeyishini.

Yi-LILW-SL ne-HLW kuphela ezikhoyo eKoeberg. I-LILW-SL ivela kwimithombo emininzi eyahlukeneyo. Ubukhulu becala yinkcitho ekhutshwayo evela kwimisebenzi yokulungisa (ngokomzekelo, oomatshini, izixhobo zokusebenza, amalaphu okucoca, njalo njalo.) okanye ekusebenzeni kwizakhiwo, njengenkcitho evela xa kusetyenzwa imichiza okanye iirhasi ezikhutshwa kwizakhiwo zenyukliya (ngokomzekelo, iifiltha nee-resin zokuhluza amanzi aphuma kwiiriyektha). Amafutha enyukliya asetyenzisiweyo ahlahlelwa njenge- HLW.

13.3 Ukulawulwa kwenkcitho ekhutshwayo eneradiyeyishini eKoeberg

Uhlolo lwePSR luhlole uqheliselo lokulawulwa kwenkcitho eKoeberg ukuze lubone ukuba le nkqubo iyasebenza na ekuqinisekiseni ukuba inkcitho iyancitshiswa kwaye igcinwa ngendlela ekhuselekileyo. Olu hlolo alufumananga kutenxa kwimimiselo yokhuseleko yamazwe ngamazwe, elizweni, nayimiyalelo kumanyathelo alandelwayo nakwiinkqubo ezisetyenziswayo ukuze kulawulwe inkcitho eneradiyeyishini eKoeberg.

Inkcitho eneradiyeyishini yeLILW-SL neyeHLW ziyaveliswa eKoeberg xa kusetyenzwa naxa kulungiswa. Inkcitho eneradiyeyishini iyaveliswa naxa kutshintshwa izixhobo ezinkulu kuze kufakelwe ezintsha naxa kusenziwa iinguqu ekubeni kulahlwa iikhomponenti zindala. Isicwangciso Sokulawulwa Kwenkcitho Eneradiyeyishini YaseKoeberg idandalazisa imijelo yenkcitho eneradiyeyishini eveliswa yiKoeberg kwaye igunyaziswe liSebe Lezimbiwa Namandla.

Kuveliswa izicwangciso zokulawulwa kwenkcitho ezenzelwe into ethile ukwenzela ukutshintshwa kweekhomponenti ezinkulu (njengeetanki zamadama amafutha kunye nemibane yokuvelisa umphunga osetyenzisiweyo eziye zatshintshwa kunye neenjini zomphunga ekucetywa ukuba kwixesha zitshintshwe elingephi). Ezi zicwangciso zigunyaziswa yiKomiti Yelizwe Yokulawulwa Kwenkcitho Eneradiyeyishini. Izicwangciso zokulawula inkcitho zijoliswe ekunciphiseni inkcitho eneradiyeyishini nokulungiselela ukuba igcinwe ize ilahlwe ngendlela ekhuselekileyo.

Ukugcinwa kwamafutha asetyenzisiweyo (HLW) kuthethwa ngako kwicandelo 13.4. Ewonke amafutha asetyenzisiweyo aveliswe ukususela oko saqala ukusebenza esi sitishi aboniswe kwiTheyibhuli 7. Zimalunga ne-55 iiassemblies zamafutha

asetyenzisiweyo ezifuna ukugcinwa emva komjikelo wokutshintsha amafutha ngamnye (ekungenzeka yahluke kuxhomekeka kwizinto ezinjengobude bexesha lemijikelo yokutshintsha amafutha). Ewonke amafutha asetyenzisiweyo (HLW) mancinane kakhulu xa kuthelekiswa, ngokomzekelo, namalahla: i-1 kg yamafutha enyukliya (U-235) inamandla awaphindaphinda kangangezigidi ezibini ukuya kwezithathu amandla e-1 kg yamalahla. Umlinganiselo wamafutha asetyenzisiweyo kwiminyaka eyi-60 yokusebenza kweKoeberg ungakwazi ukulingana kwityhubhu emalunga ne-10 m x 10 m x 10 m. Kakade ke, indawo yokuyigcina bekuya kufuneka kwaye nkulu ukuze akwazi ukupholiswa, ukugqunywa, ukupakishwa, nokubekwa esweni.

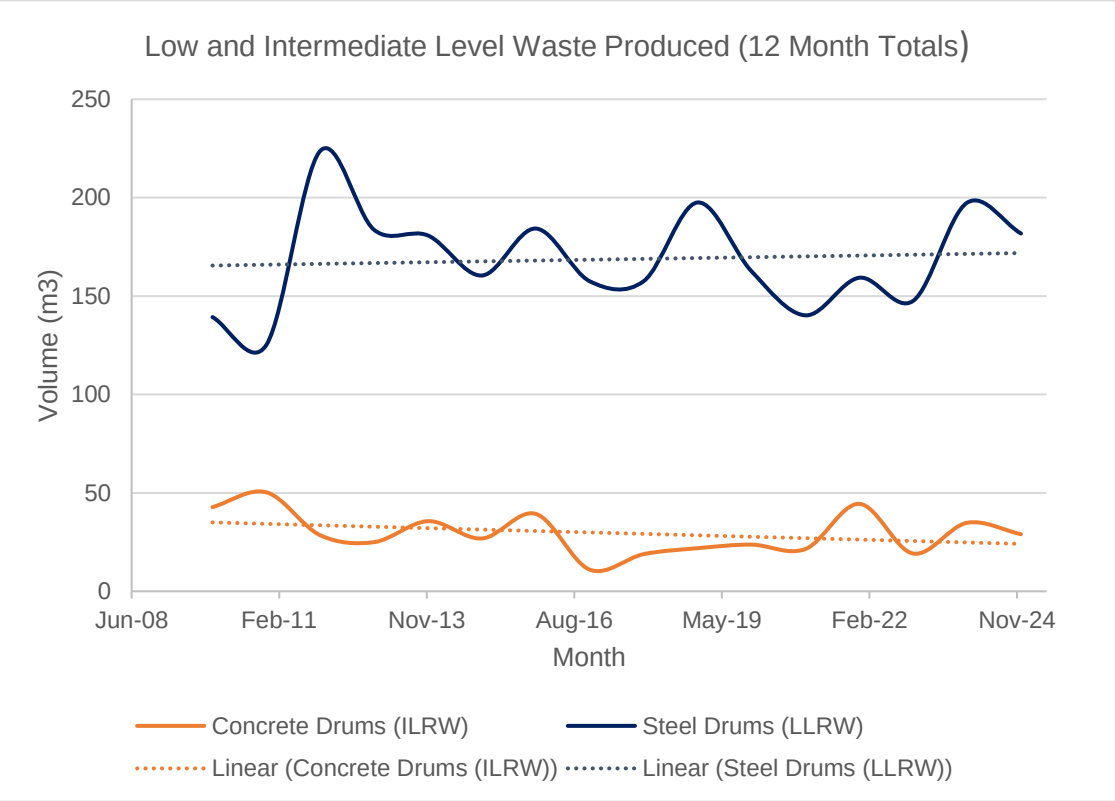
Itheyibhile 7: Ewonke amafutha asetyenzisiweyo aveliswe ukususela oko saqala esi sitishi ukuya kutsho ku- 2025

	Imigqomo yokugcina	**Idama lamafutha asetyenzisiweyo Iyunithi 1**	**Idama lamafutha asetyenzisiweyo Iyunithi 2**	**Zizonke ii-assembly zamafutha asetyenzisiweyo**
Inani lee-assembly zamafutha	496	1 117	1 172	2 845

Umfanekiso 21 umela izimbuku zeenyanga eziyi-12 zomlinganiselo wenkcitho eyi-LILW-SL eveliswe eKoeberg kwixesha lePSR. Umthamo wemigqomo yentsimbi evelisiweyo uzinzile, imilinganiselo ephakathi imalunga ne-170 m^3 ngonyaka, noxa umlinganiselo wemigqomo yekhonkrithi evelisiweyo wehlile ngexesha lohlolo lwePSR (2009 - 2024). Umlinganiselo wenkcitho evelisiweyo usondele noko xa kuthelekiswa nemilinganiselo ephakathi yezinye izitishi, ngaphandle kwe-resin yenkcitho ekwinqanaba eliphantsi, iizisefo zokusefa amanzi enkcitho ekwinqanaba eliphakathi, nayo yonke inkcitho ekhutshwayo, eziphezulu xa zithelekiswa neUSA neFransi. Unobangela walo mahluko kukusetyenziswa kweendlela ezahlukileyo xa kusetyenzwa i-resin yenkcitho ekwinqanaba eliphantsi, iKoeberg eyiphatha njengenkcitho, kodwa esuswa okanye elahlwa njengenkcitho ekwinqanaba eliphantsi kakhulu eUSA neFransi.

Inkcitho eneradiyeyishini eveliswe eKoeberg igcinwa ngendlela yokuba kukwazeke ukuyisusa, ukuyisebenza, kunye/okanye ukuyilahla kamva okanye, kwimeko yezinto ezichithwayo, ikhutshwe ngokogunyaziso kulandelwa imida ebekwe yimiyalelo. Ingcamango ethi “libazisa ukuze ibole (delay and decay)”, “qokelela ndawonye uze uyivalele (concentrate and contain)”, nethi “yivange uze uyisasaze (dilute and disperse)” ngaphambi kokuba inkcitho ithuthelwe kwindawo yokulahla inkcitho eneradiyeyishini iyasetyenziswa. Le nto iqinisekisa ukuba idowusi eya kuluntu nakokusingqongileyo igcinwa

ALARA iphantsi kangangoko kunokufikeleleka. Inani lee-radionuclide kwinkcitho eneradiyeyishini esiwa kwindawo yokulahla inkcitho liyabhalwa ize lilandelelwe.



Umfanekiso 21: Inkcitho ekhutshwayo ekwinqanaba eliphantsi neliphakathi eveliswa eKoeberg

13.4 Ukugcinwa kwenkcitho ekhutshwayo ekwinqanaba eliphezulu, eliphakathi, neliphantsi

Sithethanje, amafutha asetyenzisiweyo (HLW) agcinwa ngokukhuselekileyo kumadama amafutha asetyenziswe ziiyunithi nakwimigqomo egqina amafutha eKoeberg. Kuye kwaphuhliswa indlela yokulawula amafutha asetyenzisiweyo ukuze kulungiselelwe ukugcinwa ixesha elide nokulahlwa ekugqibeleni kwamafutha asetyenzisiweyo. Amafutha asetyenzisiweyo aza kuqhubeka egcinwa kumadama amafutha asetyenzisiweyo ubuncinane iminyaka eyi-10 ukuze kuncitshiswe amandla aye kumaqondo amkelekileyo ngaphambi kokuba afakwe kwimigqomo yokuwagcina kwisiza saseKoeberg. Amadama amafutha asetyenzisiweyo kunye nemigqomo yokuwagcina ziindlela ezikhuselekileyo nezinokuthenjwa zokugcina iHLW kwaye zihambisana neendlela

ezisetyenziswa kumazwe ngamazwe sithethanje. Umfanekiso 23 no Umfanekiso 22 ibonisa i-assembly yamafutha isiwa elugcinweni kwidama lamafutha asetyenzisiweyo nakwimigqomo yokugcina, ngokulandelelana. I-NNR ikhuphe i-NIL-044, i-Variation 4, evumela ukwakhiwa kwe-TISF yokuqala yokuGcina i-Fuel Cask kwindawo yaseKoeberg.

Umfanekiso 22: I-assembly yamafutha isiwa elugcinweni kwidama lamafutha asetyenzisiweyo elifana nelaseKoeberg

Umfanekiso 23: Imigqomo yokugcina amafutha ekufakwa kuyo ii-assembly zamafutha enyukliya

IKoeberg ilungiselela ukuba kubekho isakhiwo sokugcina izinto sexeshana (TISF), ukuba iNNR iyagunyazisa, ukuze kugcinwe kuso eminye imigqomo yokugcina amafutha enyukliya asetyenzisiweyo.

Ukuthetha noluntu, nokuthetha nabachaphezelekayo, kuza kwenziwa ebudeni bamanqanaba ahlukeneyo enkqubo yokulawula amafutha asetyenzisiweyo. Isakhiwo esisembindini sokugcina okwexeshana (centralised interim storage facility [CISF]) siyakhiwa kwaye siza kuza nesigaba esilandelayo sokugcinwa kwamafutha asetyenzisiweyo. De ibe isungulwe iCISF liZiko Lelizwe Lokulahlwa Kwenkcitho Eneradiyeyishini (NRWDI), iKoeberg iza kuqinisekisa ukuba amafutha asetyenzisiweyo agcinwa ngendlela ekhuselekileyo esizeni. Ngenxa yoko, indawo yokugcina (imigqomo) iyandiswa, ukuba iNNR iyagunyazisa (ibizwa ngokuba sisakhiwo sokugcina sexesha elifutshane). Umgaqo-nkqubo Nendlela Yokulawula inkcitho Ekhutshwayo Eneradiyeyishini kwiRiphabliki YoMzantsi Afrika [37] ivumela ukuba igcinwe ukuya kutsho kwiminyaka eyi-100. Emva koko, lo mafutha asetyenzisiweyo aya kufakwa kwinto engcityiweyo iza imbelwe kumngxuma onzulu osemhlabeni.

Ngokuhamba kwexesha, iKoeberg iza kuqhubeka ibeke esweni amanyathelo athathwe ehlabathini nophuhliso olutsha ukuze iqiniseke ukuba kusetyenziswa ezona ndlela zifanelekileyo zokulahla amafutha asetyenzisiweyo. IKoeberg iza kulungiselela izicwangciso zobugcisa nezemali ezichaza ngokweenkcukacha, kangangoko kunokwenzeka, izicwangciso zayo zolawulo lwexesha elide lwamafutha enyukliya (jonga icandelo 13.6, izicwangciso zokuvala isitishi).

Inkcitho ekhutshwayo eneradiyeyishini yeLILW-SL ifakwa kwinto engcityiweyo okanye ifakwe kwimigqomo yenkcitho ethobela oko kwamkeleke kwinkcitho ekhutshwayo yaseVaalputs kwaye igunyaziswa yiNNR. Izinto ezijongwayo ukuze yamkeleke inkcitho ekhutshwayo ezichaza iimpawu zeradiyeyishini, zokusebenza, zoqobo, zekhemikhali, nezebhayoloji zeepakeji zenkcitho ukuze kuqinisekiswe ukuba loo nkcitho ivalelwa ngendlela eyiyo ize igcinwe ngendlela ekhuselekileyo. Ngokomzekelo, uhlobo, ubungakanani, nobunzima bemigqomo ziyahlahlelwa kangangoko kunokwenzeka ukuze kuqinisekiswe ukuba ziyafana, ziyahambelana, kwaye ziphathwa ngendlela ekhuselekileyo kuzo zonke iinkqubo zokulawulwa kwenkcitho.

Xa isalinde ukuthuthwa isiwe eVaalputs, iLILW-SL igcinwa kwisakhiwo senkcitho ekwinqanaba eliphantsi kwisiza saseKoeberg. Kulungiselelwe ukuba ibekwe esweni, ihlolwe, kwaye ilungiswe qho le nkcitho kunye nesakhiwo senkcitho ekwinqanaba eliphantsi ukuze kuqinisekiswe ukuba siqhubeka sithembekile. Xa kukho nakuphi na ukuwohloka kwemeko yesakhiwo okubonwe ebudeni bokuhlolwa kwaso, kuye kulungiswe ngokwamanyathelo alandelwayo afanelekileyo. Le nto iza kuqhubeka isenziwa nangexesha leLTO.

Isiza sokulahla inkcitho saseVaalputs sisebenza phantsi kwemiqathango yaso yelayisenisi yenyukliya. SikuMntla Koloni kwaye siyilwe ngohlobo lokuba sikwazi ngokwaneleyo ukuthwala inkcitho yeLILW-SL evela eKoeberg. Ukulahla kwesi siza kuqhutywa ngokwemimiselo yelayisenisi yenyukliya. Ngo-2019, uEskom uye wazisa ngokusemthethweni iNRWDI ukuba iKoeberg igqibe kwelokuba yenze iLTO, ukuba iyagunyaziswa yiNNR, yaza yacela iNWRDI ukuba yongeze ixesha lokusebenza kweVaalputs ukuze isingathe iLTO. Indawo yokugcina eseleyo eVaalputs yanele ukuthwala inkcitho eveliswe ebudeni bexesha leLTO kwaye ixhomekeke ekugunyazisweni yiNNR. I-NRWDI ingqinile ukuba iza kuhlala ivulile isebenza, kwaye inakho ukugcina yonke iLLW eveliswe eKoeberg ngalo lonke ixesha isaqhubeka iLTO.

Iwebhusayithi yeNRWDI inenkcazelo eneenkcukacha ngokugcinwa kwenkcitho eneradiyeyishini ngendlela ekhuselekileyo. Le ndawo ineempawu ezenza umhlaba

wayo ufaneleke njengokungafane unyikime. Imisele egcina inkcitho yaseVaalputs inobunzulu obuziimitha eziyi-8, ingqongwe ludongwe, kwaye ikwiimitha eziyi-50 ngaphezu kwamanzi aphantsi komhlaba. Xa le misele izele yimigqomo yenkcitho, iyaditywa ize ingcitywe ngodongwe olugangathiweyo oluziimitha ezi-2 ukuze amanzi emvula angangeni ngaphambi kokuba zigutyungelwe ngesanti kuze kutyalwe izityalo ebezilapho ngaphambili. Umfanekiso 24 ubonisa isiza sokugcina yaseVaalputs.

Umfanekiso 24: Indawo yokulahla inkunkuma yaseVaalputs [29]

13.5 Inkcitho ekhutshwayo eneradiyeyishini kwiLTO

Inkcitho ekhutshwayo eneradiyeyishini iza kuqhubeka ilawulwa ngokweKoeberg NIL-01 [1] nangoMgaqo-nkqubo Yelizwe Nendlela Yokulawula Inkcitho ekhutshwayo Eneradiyeyishini [37] ebudeni bexesha leLTO.

Uhlobo lwenkcitho eza kuveliswa ngenxa yeLTO luza kufana nohlobo lwenkcitho oluveliswe ukuza kutsho ngoku. Sithethanje inkcitho igcinwa ngendlela ekhuselekileyo esizeni okanye eVaalputs. Ikho indlela yokugcina ngokukhuselekileyo zonke iintlobo zenkcitho eveliswa eKoeberg ngalo lonke ixesha lokusebenza kwayo, kuquka iLTO.

I-PSR ingqinile ukuba iinkqubo namanyathelo alandelwayo eKoeberg okulawula inkcitho zihambisana noko kufunwa lilizwe, ngamazwe ngamazwe, nayimiyalelo kulawulo lwenkcitho eyirhasi, engamanzi, nenkcitho eqhelekileyo.

13.6 Isicwangciso sokuvala isitishi nemali

Ukuba nesicwangciso sokuvala isitishi esinikwa iNNR ngomnye wemiqathango yeKoeberg NIL-01. Isicwangciso yokuvala isitishi simele sithunyelwe kwiNNR ngaphambi kokuba kuqaliswe imisebenzi yokuvala, kwaye iKoeberg imele ibonise ukuba inabasebenzi nemali eyaneleyo ukuze kuphunyezwe inkqubo yokuvala isitishi.

Kukhethwe indlela yokuvala isitishi ye-“DECON” (decontamination and dismantling [ukuhlanjwa nokuchithwa ngoko nangoko]), njengeyona iza kusebenza eKoeberg. UEskom uphuhlise isicwangciso sokuvala isitishi, ebesicinga ngeminyaka eyi-60 yokusebenza, ngokuhambisana nesikhokelo semiyalelo seNNR esiphathelele ukuvalwa kwezakhiwo zenyukliya [32].

UEskom ulungiselele ukuba kubekho imali eyaneleyo, njengoko kuboniswe kwingxelo yakhe yemali yonyaka, ukwenzela ukuvalwa kweKoeberg, kuquka ukulungisa umhlaba ochaphazelekayo nokulawula ii-assembly zamafutha asetyenzisiweyo nenkcitho eneradiyeyishini. Le mali iyahlolwa unyaka nonyaka.

14. UKUTHUTHWA KWENKCITHO ENERADIYEYISHINI NEZINTO EZINERADIYEYISHINI

UMzantsi Afrika lilungu le-IAEA kwaye usebenzisa imiyalelo yothutho ebekwe echazwe kwiZinto Ezifunwayo Yi-IAEA zokhuseleko, Izinto Ezifunwa Ngokungqalileyo Kukhuseleko, SSR-6 ukuze kuhanjiswe izinto ezineradiyeyishini ngokhuseleko [31]. Ezi zinto zifunekayo ziye zafakwa kwimiqathango yelayisenisi yaseKoeberg (NIL-01). Ugunyaziso oluvela kwi- NNR lumele lufunyanwe ngaphambi kokuba naziphi iimathiriyali ezineradiyeyishini zihanjiswe.

Injongo yokusebenzisa imimiselo yokuthutha yeIAEA nokuyifaka kwiNIL-01 kukuqinisekisa ukuba imathiriyali nenkcitho eneradiyeyishini ithuthwa ngendlela ekhuselekileyo. IKoeberg iyithutha ngendlela ekhuselekileyo inkcitho ekhutshwayo eneradiyeyishini ngokuthobela iimfuno ezibekwe kwimigaqo yezothutho yeIAEA, equka iindlela zokuvalela izinto ezineradiyeyishini, ukuzigquma, nokulawula iqondo ledowusi elingaphandle. Ezi zinto zifunwayo zifikelelwa ngokuthi kuhlangatyezwane nemigangatho yoyilo yokupakisha inkcitho nangolawulo.

Ebudeni bexesha leLTO, amafutha amatsa enyukliya noomatshini abaneradiyeyishini abasetyenziswe xa kulungiswa ziza kuqhubeka zihanjiswa ngolwandle (ngenqanawa) zisiwe kwichweba laseKapa kusetyenziswa izikhongezeli (iikhonteyina) zentsimbi

ezomeleleyo eziyilwe ngokukhethekileyo. Inkcitho ekhutshwayo eneradiyeyishini (LILW) eveliswe ngexesha leLTO iza kuthuthwa ngezithuthi ezihamba endleleni isiwe kwindawo yokulahla inkcitho ekhutshwayo eneradiyeyishini yaseVaalputs. Loo nto iza kwenziwa kuthotyelwa imiyalelo yothutho yeIAEA [31].

15. ISISHWANKATHELO SEMISEBENZI YE-LTO

Ekulungiseleleni iLTO, uEskom wenze uhlolo lokhuseleko ukuze kuqulunqwe imisebenzi edingekayo ukuze kwandiswe ixesha uEskom esebenza (iLTO ekhuselekileyo). Olu hlolo lugqityiwe lwaye luquke:

- Imiba yokhuseleko yeIAEA kwinkqubo yexesha elide (SALTO)
- Uhlaziyo lokhuseleko rhoqo (PSR)
- Uphando kwiziko
- Uphando ngobomi bezityalo

Zonke izinto zokuphucula ukhuseleko ezifunyenwe ngexesha lokuvavanywa kokhuseleko kwaye ezifunekayo kwiYunithi 1 nakwiYunithi 2 ngaphambi kokungena kwi-LTO zigqityiwe. Itheyibhile 9 inika isishwankathelo semisebenzi egqityiweyo.

Itheyibhile 8: Isishwankathelo semisebenzi egqityiwe phambi kweLTO

Nomb.	LTO umsebenzi	Inkcazelo yomsebenzi nendima eseyihanjiwe
1	Hlaziya ingxelo yohlalutyo lokhuseleko	Ingxelo yokhuseleko (SAR) yenye yamaxwebhu edizayini eKoeberg. Iyahlaziywa rhoqo xa kwenziwe uphuhliso. Zonke iinguqulelo ze-SAR ezinxulumene ne-LTO zigqityiwe ukulungiselela i-LTO.
2	Qulunqa ungenise ingxelo yokugqibela yeSALTO yohlolo lokuguga	Ingxelo yokugqibela yeSALTO iqulethe iinkcukacha ngokuhlaziya ulawulo lokuguga kwezixhobo ngeprojekthi yeSALTO. Ingxelo yokugqibela yoVavanyo lokuGuga kweSALTO igqityiwe kwaye ingeniswe kwi-NNR. Ikwafumaneka kwiwebhsayithi ka-Eskom.
3	Uhlalutyo ngokuguga okulawulwa lixesha (TLAAs)	I-TLAA luhlalutyo lwenjineli lokufumanisa ukuba isebe elithile leziko okanye isakhiwo siyachatshazelwa na emva kwexesha zizinto ezinjengokuchachamba, isamente eyonakalayo, ukufinyela, ukuchachamba kweenyutroni, njl. Zonke ii-TLAAs zigqityiwe ngaphambi kokungena kwi-LTO.
4	Uhlolo olwenziwa kanye	Uhlolo olunje luyenziwa ukuze kubonwe, kuqinisekwe ngobume bezixhobo nokuthi zifumana ulawulo olululo

		lokuzikhusela kwingozi yokuguga. Iziphumo zolu hlolo ingaba kukwenza olunye uhlolo ekuhambeni kwexesha, kuhlaziywe nenkqubo yokuzikhusela ekugugeni. Zonke iimvavanyo zexesha elinye zigqityiwe.
5	Ukutshintsha uphehlo lombane ngolophu (SG) kunye neSG *snubber*	I-SGs zizitshintshi zobushushu ezinkulu ezisetyenziselwa ukudlulisela ubushushu obuvela kwi-reactor coolant ukuya kwinkqubo yamanzi okutya. Ubushushu bujika amanzi abe ngumphunga ukuze kuqhutywe iiturbines. I-SG snubbers ziinkxaso zokuthintela i-SGs. Ii-SG zithatyathelwe indawo kwiYunithi yoku-1 neyesi-2. I-SG snubbers yeYunithi 1 itshintshiwe. Iiyunithi ezi-2 ze-snubbers zicwangciselwe ukutshintshwa ngexesha le-LTO. Kufuneka kuqatshelwe ukuba ukutshintshwa kwee-SG snubbers sisicwangciso sokulawula ukuguga.
6	Ukutshintshanisa ngezigunyaziswe ngokusingqongileyo	Ezinye izixhobo ziyakwazi ukusebenza kwiimeko eziqatha, kodwa ubomi bazo buyanqumlelwa ngokokuba zisesichengeni sobushushu, iradiyeshini, njl. Iinxalenye ezichongiweyo ukuze zitshintshwe sele zitshintshwe ngempumelelo.
8	Hlaziya ingxelo yaseDuynefontyn yokhuseleko lweziko (DSSR)	Ingxelo yokhuseleko ichaza zonke iimpawu zeziko ezinokuyibeka iKoeberg esichengeni seenyikima, iitsunami, umoya obhudlayo, etc. Uphononongo oluninzi lugqityiwe, nengxelo sele isecicini lokugqitywa. Iprojekthi yokuguqula udonga olwenziwe ngamatye igqityiwe.
9	Yenza uqiniso lodonga	Kukho iindonga ezisondele kakhulu kwizixhobo ezinobuthathaka esezichongiwe ukuba ziqiniswe zomelezelwe ukuba zingadiliki xa kungenzeka kube kho inyikima kuba zingawela izixhobo zeli ziko lombane. Inkqubo ye-KM iye yaphunyezwa ngempumelelo kwaye ihlala isebenza ngokuqhubekayo ukuxhasa ukuphuculwa okuqhubekayo.
10	Ulawulo lolwazi (KM) malwenzeke kuwo onke amasebe kwiNOU	Ulawulo lolwazi lwenza zisebenziseke kakuhle iinkcukacha/data ezifumanekayo (amaxwebhu, iidatabase, ubungcali, amava, njl) kwiqumrhu ukuze liphuhlise iziphumo zalo.

Eminye imisebenzi yokwenzelwa iLTO akunyanzelekanga igqitywe ngaphambi kweLTO kuba lo msebenzi awubalulekanga kubomi becandelo ngaphaya kweminyaka eyi-40 ngele kokuba kuphuhliswe ukhuseleko ngexesha leLTO. Le misebenzi ayihambi phambi kweLTO. Kule misebenzi kukho iindawo zokukonektha amanzi, namatanki amanzi azakuthi apholise iiriektha, ukuthotywa kokuvuza kwigumbi lobuxhakaxhaka kutsho kwehle amaqondo

eradiyeshini xa kunokubakho ingozi, neICCP yokuthintela irusi kwintsimbi exhase isakhiwo sesamente esikhuselayo.

Ezinye izixhobo ziza kutshintshwa kufakwe ezitsha ngexesha leLTO (ucimo 127 kuYunithi 1). Kuvumelekile oku emva kohlalutyo olwenziwe kaninzi ukubonisa indlela ekhuselekileyo yokusebenza iminyaka engaphaya ku-40. Kodwa kunjalo, iKoeberg igqibe ekubeni iphuhlise la macandelo ukuze ukhuseleko lube luqilima. Ukutshintsha izixhobo kufakwe ezitsha - ezinjengee-*pressure heater* ezinyusa amaqondo obushushu bamanzi, nee-*containment penetration connectors* izixhobo ezikonektha ezingaphakathi kunye nezingaphandle – zonke zingena kolu luhlu.

Okokugqibela imisebenzi eza kugqityezelwa iza kufumana isikhokelo kwiNNR ekuza kuthi kugqibe yona ngesicelo sikaEskom seLTO.

16. UKUQUKUMBELA

IKoeberg oko iqhubeka isebenza ngokukhuselekileyo ngaphezu kweminyaka eyi-39 kwaye igcine imeko yezakhiwo ikwimeko elindelekileyo kweli candelo loshishino. Ukutyhubela eli xesha, iKoeberg ibihlaziya ize itshintshe umsebenzi noqheliselo lolawulo lwayo ngokusebenzisa izilinganiso, uhlolo lokhuseleko, ukuhlolwa ngoogxa bayo abahlukeneyo, nokuphunyezwa kophuculo lwesi sitishi kaliqela. Indlela oluqhuba ngayo ukhuseleko nemigangatho, ngenxa yoko, zikwinqanaba elilindelekileyo kwisitishi sombane wenyukliya sale mihla.

Kuye kwaboniswa ukuba akukho mngcipheko ungafanelekanga kukhuseleko, kwimpilo, okanye kokusingqongileyo. IKoeberg ngaphantsi kwemida eyibekelwe yimiyalelo, kuquka imida yomngcipheko (into eyintloko ejongwayo kukhuseleko), imida yedowusi kuluntu nasemsebenzini, nemida yokuchithwa kwezinto ezikhutshwayo. Umda wedowusi usetwe ngaphantsi kakhulu kwamaqondo ekulindeleke ukuba adale umonakalo. Iinkqubo zokubeka esweni neenkqubo zokulawula ezingqingqwa zikho (kubandakanywa nemigaqo ye-ALARA) ukuze kuqinisekiswe ukuba iKoeberg iza kuqhubeka isebenza ngaphantsi kwemida yomngcipheko, yedowusi (kuluntu nasemsebenzini), nasekukhutshweni kwezinto ezilahlwayo ebudeni balo lonke ixesha leLTO.

Ukulungiselela iLTO kwenziwa ngokuhambisana nezinto ezifunwa kumazwe ngamazwe, elizweni, nayimiyalelo. Ithotyelwa ngokupheleleyo ngokukhethekileyo imiyalelo yeLTO [2]. I-PSR neSALTO eziphelelleyo ziye zenziwa kulungiselelwa iLTO. I-PSR inikele ngohlolo olugubungela konke lokhuseleko eKoeberg yaza yagqiba kwelithi

kuyaxhaswa ukusebenza ngendlela ekhuselekileyo, kuquka nangeLTO. Ulawulo lokuguga eKoeberg luye lwahlolwa ebudeni bePSR neSALTO, kwaye ingqiniwe into yokuba iinkqubo zokulawula ukuguga zingayixhasa ngendlela ekhuselekileyo iLTO. Izinto ezifuna ukuphuculwa kukhuseleko ezibonwe ebudeni bePSR ziza kwenziwa ngamaxesha afanelekileyo.

Uphononongo lovavanyo lwesiza olwenziwa ngaphambili lubonise ukuba akukho zithintelo zifunyenweyo ezinokwenza ukuba isiza singafaneleki kusetyenziso oluqhubekayo lwenyukliya. Ezi zifundo zihlaziywa ngoku, zithathela ingqalelo izifundo ezifunyenwe kwingozi yaseFukushima kunye nokuqinisekisa okona kuhlaziyiweyo nokuqonda okuchanekileyo kwesi siza kusetyenziswa ulwazi olukhoyo lwamva nje, iimfuno zolawulo, kunye neendlela zokuhlalutya. IKoeberg inezibonelelo zedizayini kunye nezixhobo ezenza ukuba ikwazi ukusebenza khuselekileyo nokuba kungakho iinyikima neetsunami, kanti kukho nezinye izicwangciso zokuqhubeka nophuhliso ngexesha leLTO.

IKoeberg ineenkqubo eziyimfuneko zolawulo, iinkqubo zokulawula abasebenzi, nezakhiwo zokuqeqesha ukuze iqiniseke ukuba bakho abasebenzi abaneleyo, abakwazi ukusebenza abaza kuxhasa iLTO. Iinkqubo zokulawula ulwazi zaseKoeberg, ngeli xesha zisphuhliswa, zenza abasebenzi bakwazi ukudala ulwazi olutsha kunye kwaye baqiniseke ukuba ulwazi olubalulekileyo luyafumaneka kubasebenzi abaludingayo. Indlela ekuqhutywa ngayo emsebenzini eKoeberg kunye nokuqhelwa kokhuseleko zikwimo eyamkelekileyo.

Ngokuhambelana noMthetho Wokulawulwa Kwemali KaRhulumente kunye nomthetho oxhobisayo onxulumeneyo, iSigqeba SakwaEskom siqwalasela size sigqibe ngendlela eza kufunyanwa ngayo imali yokusebenza kwaEskom, ukujonga imali efunekayo kwaEskom, ngamaxesha athile. UEskom uzibophelele ekwenzeni imali ifumaneke ukuze kukwazeke ukusebenza ngendlela ekhuselekileyo nenokuthenjwa kwixesha leLTO.

Zikho izicwangciso zokugcina zokugcina nokulahla ngokukhuselekileyo zonke iintlobo zenkcitho eneradiyeyishini eveliswa eKoeberg ngalo lonke ixesha lokusebenza kwayo, kuquka iLTO.

IKoeberg ihlola ngendlela esebenzayo ize ibeke esweni imisebenzi eyenziwa kuyo, noxa iNNR inikela ngobunkokeli obungqongqo nokubeka esweni ukuthotyelwa kwemiyalelo. Oku kusebenzisana ekucokiseni kuyenza ithenjwe into yokuba iKoeberg iza kuqhubeka ivelisa umbane okhuselekileyo, nococekileyo ngalo lonke ixesha leLTO.

YEKAWONKE-WONKE

Isicelo selayisensi sokusebenza iKoeberg ukuya kuma kwiminyaka eyi-60 siza kuhlalelwa yiNNR.

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