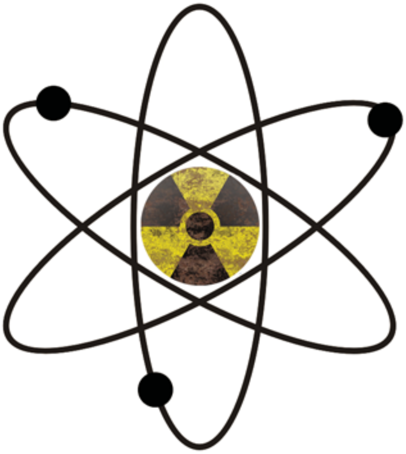
genesisreactor4

для нас как людей



*to us as humans*

*"one of the most extraordinary consequences of human consciousness is the ability it gives us to imagine things that are physically impossible. by this device we can explore reality in a unique way, placing it in a context defined by impossible events. in this way we are able to create resonances of meaning and juxtapositions of ideas which are mind-stretching and stimulating."*

*-john d. barrow,* other realities

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# judgment

*t minus 24 hours*

## 25 April 1986

*01:06*

*start of reactor power reduction in preparation for the experiments and the planned shutdown of unit no. 4.*

*03:47*

*reactor power reduced to 1600 mw of thermal power, which was 50% of the maximum thermal power of the reactor.*

*13:05*

*of unit no. 4's two turbine generators, numbers 7 and 8, turbine generator number 7 was tripped [shutdown] from the electricity grid and all its working load, including four of the main circulating pumps, transferred to turbine generator number 8.*

*14:00*

*as part of the experimental programme, the reactor's emergency core cooling system was disconnected. however, the experiment was subjected to an unplanned delay because of a request by the electricity grid controller in kiev to continue supplying the grid till 23:10 hours. this was agreed to by the chernobyl npp staff, but the reactor's emergency core cooling system was not switched back on.*

*23:10*

*the reduction of the reactor's thermal power was resumed, since in accordance with experimental procedure the test was to be performed at 700 mw and 1000 mw thermal power.*

## 26 April 1986

*00:05*

*thermal reactor power 720 mw; steady unit power reduction continues.*

*00:28*

*thermal reactor power at around 500 mw. on going to low power, the set of control rods used to control reactor power at high powers [called local automatic control rods or lacs] were switched off and a set of control rods called the automatic control rods [acs] were switched on. however, the operators had failed to reset the set point for the acs. because of this, they were unable to prevent the reactor's thermal power falling to only 30 mw, a power level far below the 700-1000 mw intended for the experiment. [later investigations suggest that the system was not working properly, the cause was unknown and hence there was inability to control the power. therefore, as such, there was no operator error.*

*01:00*

*the operators succeeded in stabilizing the reactor at 200 mw thermal power, although this was made difficult due to xenon poisoning of the reactor. the 200 mw level was only achieved by removing control rods from the core of the nuclear reactor. nevertheless, 200 mw was still well below the required power level and the experiment should not have proceeded.*

*01:03 to 01:07*

*the two standby main circulating pumps were switched respectively into the left and* *right loops of the coolant circuit. eight main pumps were now working and this procedure was adopted so that when, at the end of the experiment in which four pumps were linked to turbine generator number 8, four pumps would also remain to provide reliable cooling of the reactor core. however, due to the low power of 200 mw and the very high [115-120% of normal] coolant flow rate through the core due to all eight pumps functioning, some pumps were operating beyond their permitted regimes. the effect was a reduction in steam formation and a fall in pressure in the steam drums.*

*01:19:00*

*the operators tried to increase the pressure and water level by using the feedwater pumps. the reactor should have tripped because of the low water level in the steam drums, but they had overridden the trip signals and kept the reactor running. the water in the cooling circuit was now nearly at boiling point.*

*01:19:30*

*the water level required in the steam drums is reached, but the operator continues to feed water to the drum. the cold water passes into the reactor core and the steam generation falls further, leading to a small steam pressure decrease. to compensate for this, all 12 automatic control rods [acs] are fully withdrawn from the core. in order to maintain 200 mw thermal power, the operators also withdrew from the core some manual control rods.*

*01:19:58*

*a turbine generator bypass valve was closed to slow down the rate of decrease of steam pressure. steam is not dumped into the condenser. steam pressure continues to fall.*

*01:21:50*

*the operator reduces the feed water flow rate to stop a further rise in the water level. this results in an increase in the temperature of the water passing to the reactor.*

*01:22:10*

*automatic control rods [acs] start to lower into the core to compensate for an increase in steam quality.*

*01:22:30*

*the operator looks at the printout of the parameters of the reactor system. these are such that the operator is required in the written rules to immediately shut down the reactor, since there is no automatic shutdown linked to this forbidden situation. the operator continues with the experiment. the number of control rods in the reactor core was six to eight, which represents less than one-half the design safety minimum of 15, and less than one-quarter the minimum number of 30 control rods in the operator's instruction manual.*

*01:23:04*

*the experiment is started with the reactor power at 200 mw, and the main line valves to the turbine generator number 8 were closed. the automatic safety protection system which trips the reactor when both turbine generators are tripped was deliberately disengaged by the operators, although this instruction was not included* *in the experimental schedule. operation of the reactor was not required after the start of the experiment.*

*01:23:05*

*the reactor power begins to rise slowly from 200 mw.*

*01:23:10*

*the automatic control rods [acs] are withdrawn.*

*01:23:31*

*the main coolant flow and the feedwater flow are reduced, causing an increase in the temperature of the water entering the reactor, and an increase in steam generation. the operators noted an increase in reactor power.*

*01:23:40*

*a reactor power steep rise [prompt critical excursion] was experienced, and the unit no. 4 shift foreman ordered a full emergency shutdown [emergency scram]. unfortunately the order came too late. not all the control rods reached their lower depth limits in the core and an operator unlatched them in order to allow them to fall to the positional limits under gravity. however, since the rods had been nearly withdrawn, a delay of up to 20 seconds would have had to occur before the reactor power could have been reduced. this would have been at 1:24:00.*

*01:23:43*

*emergency alarms operate, but unfortunately the emergency protection is not sufficient to stop reactor runaway. the sharp growth of the fuel temperature produces a heat transfer crisis. reactor power reaches 530 mw in 3 seconds and continues to increase exponentially.*

*01:23:46*

*intensive generation of steam.*

*01:23:47*

*onset of fuel channel rupture.*

*01:23:48*

*two explosions [both thermal] occured about 01:24 one after the other. burning debris and sparks shot into the air above the reactor, and outbreaks of fire occurred in over 30 places due to high temperature nuclear reactor core fragments falling onto the roofs of buildings adjacent to the now destroyed reactor hall. diesel fuel and hydrogen stores were also threatened and firefighting took precedence over radiation protection.[26]*

# human by nature

*introduction*

*what is the ultimate truth about ourselves? various answers suggest themselves. we are a bit of stellar matter gone wrong. we are physical machinery--puppets that strut and talk and laugh and die as the hand of time pulls the strings beneath. but there is one elementary inescapable answer. we are that which asks the question.*

*--sir arthur eddington*

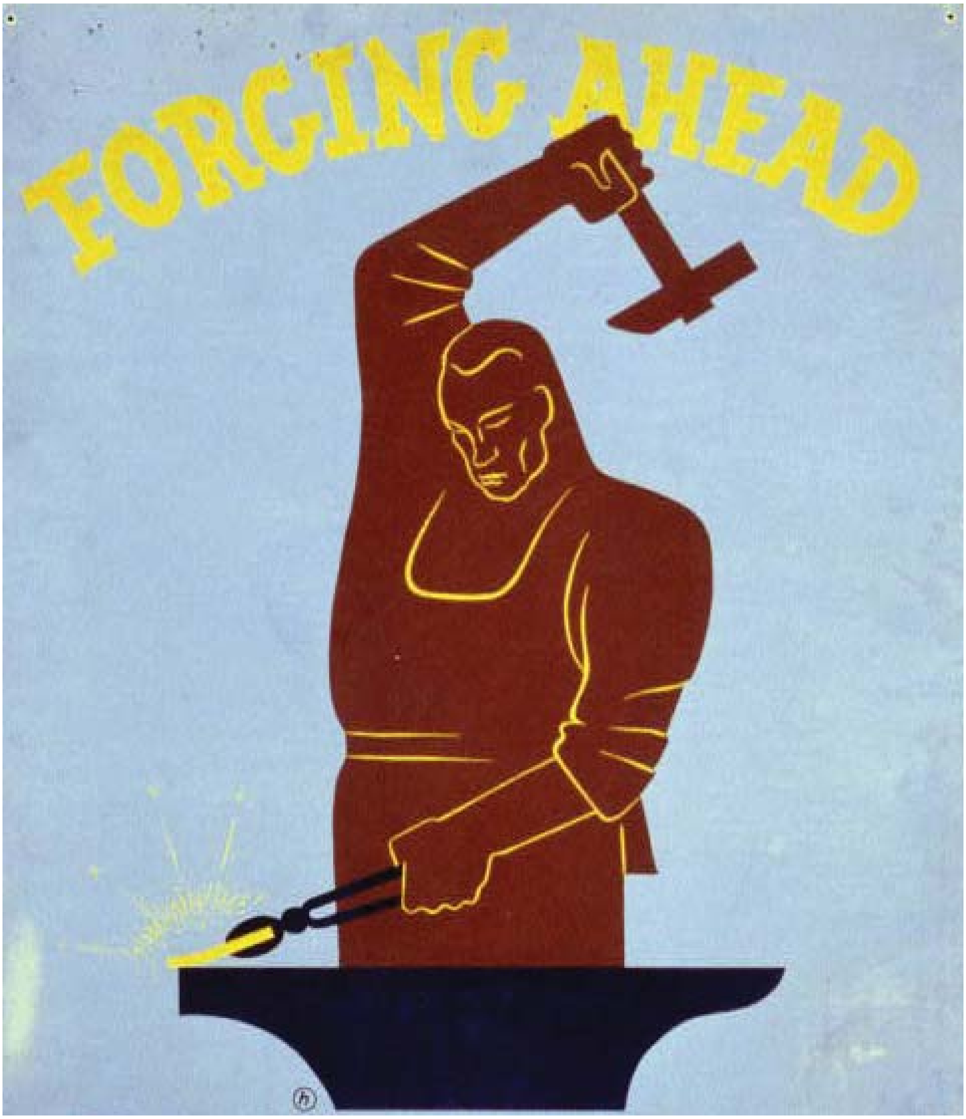
*what does it mean to be human by nature not by choice?*

*humans have a zeal for progress, for advancement. this manifests itself as invention and civilization. we imagine technology--technology constructed from elements of the earth--to manipulate the landscape for civilization: to climb for the heavens, to soar across oceans, to see the invisible, to transform the earth, to stop time, to defy death.*

*we are dreamers. we are destroyers. we are creators. and we are problem solvers, seeking to resolve even the problems that we create. these traits establish a paradoxical relationship with the environment, however: we destroy in order to create, and we create in order to destroy.*

*but this paradox is what allows us to achieve the impossible.*

*this is a reflection.*
*this is an exploration.*
*this is a response.*


FORGING AHEAD

*this statement can be interpreted as how we as humans relate to the environment--more specifically through technology in this instance. the paradox discussed in the statement resonates several times throughout this project and will be used to discuss the project in three different phases: past, present, and future. the project must address all three contexts.*

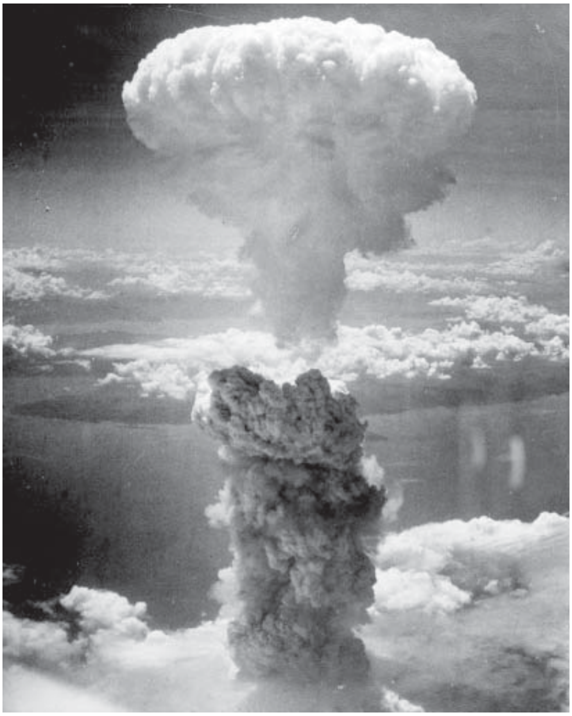
*the past deals with humanity's response to impending consequences of civilization and the significant and quite memorable history of the site.*

*the present represents the bulk of the project being explored. here, the proposed program of the botanical research center is rooted addressing the current site conditions both physical--radiation in the environment--and psychological--paranoia, morality, speculation and exploration, etc. the program responds to the history of the site directly; it can only exist on this site because of current radioactive conditions and only exists itself because of the events of the past. because of developing implementations on site, the new safe confinement, a new way to explore the site's relationship to program is revealed--radiation regeneration--further linking, even tying the program, site, history, current conditions, and future developments together.*

*the future context presents itself as an evolution of all previous occurances of the site: history, programs, site conditions--essentially, the human relationship with the environment, the unintentional monument.*

# self-infliction

*human as [destroyer]*



*we break the earth for food.*
*we cut the earth for shelter.*
*we drain the earth for fuel.*
*we nauseate the earth for civilization.*
*we ignore the earth for war.*

*[we cherish the earth for life.]*

# eversor | aboleo | exitium

## *a destroyer | to destroy | destruction*

*man has a long history of fostering a relationship with the earth. we have been using the earth for resources, protection, and survival for centuries. a delicate exchange with the earth provided a harmony between mind and matter that is almost nonexistant today. perhaps the most debatable [and apocolyptic] example of human annihilation by environmental destruction is that of rapa nui--or easter island. located in the pacific ocean, 2200 miles from the nearest major landmass, the island becomes a completely isolated environment much like that of earth but on a significantly smaller scale. here two tribes of humans competed in their race for civilization, power, and influence. in order to build and transport the symbolic moai statues, the tribes had to cut down forests for materials. deforestation of the limited resources on the island led to erosion of the land and eradication of biodiversity and ecosystems. unable to support a growing population with no access to additional means of survival, the population of people diminished.[30] the tribes' self-inflicted destruction is a direct result from their destruction of the environment.*

# radiation

*an introduction*


*radiation is energy in the process of being transmitted, which may take such forms as light, or tiny particles much too small to see. radiation particularly associated with nuclear medicine and the use of nuclear energy, along with x-rays, is 'ionizing' radiation, which means that the radiation has sufficient energy to interact with matter, especially the human body, and produce ions, i.e. it can eject an electron from an atom.*

*nuclear radiation arises from hundreds of different kinds of unstable atoms. while many exist in nature, the majority are created in nuclear reactions. ionizing radiation which can damage living tissue is emitted as the unstable atoms (radionuclides) change ('decay') spontaneously to become different kinds of atoms.*[31]

## types of radiation

*alpha particles*

*these are helium nuclei consisting of two protons and two neutrons and are emitted from naturally-occurring heavy elements such as uranium and radium, as well as from some man-made transuranic elements. they are intensely ionizing but cannot penetrate the skin, so are dangerous only if emitted inside the body.* [31]

*beta particles*

*these are fast-moving electrons emitted by many radioactive elements. they are more penetrating than alpha particles, but easily shielded – they can be stopped by a few millimetres of wood or aluminum. they can penetrate a little way into human flesh but are generally less dangerous to people than gamma radiation. exposure produces an effect like sunburn, but which is slower to heal. beta-radioactive substances are also safe if kept in appropriate sealed containers.* [31]

*gamma rays*

*these are high-energy beams much the same as x-rays. they are emitted in many radioactive decays and are very penetrating, so require more substantial shielding. gamma rays are the main hazard to people dealing with sealed radioactive materials used, for example, in industrial gauges and radiotherapy machines. radiation dose badges are worn by workers in exposed situations to detect them and hence monitor exposure. all of us receive about 0.5-1 mSv per year of gamma radiation from cosmic rays and from rocks, and in some places, much more. gamma activity in a substance (e.g. rock) can be measured with a scintillometer or geiger counter.* [31]

*x-rays*

*x-rays are also ionizing radiation, virtually identical to gamma rays, but not nuclear in origin.* [31]

*cosmic radiation*

*cosmic radiation consists of very energetic particles, mostly protons, which bombard the earth from outer space.*[31]

*neutrons*

*neutrons are mostly released by nuclear fission (the splitting of atoms in a nuclear reactor), and hence are seldom encountered outside the core of a nuclear reactor. thus they are not normally a problem outside nuclear plants. fast neutrons can be very destructive to human tissue.* [31]

## units of radiation and radioactivity

the basic unit of radiation dose absorbed in tissue is the gray (Gy), where one gray represents the deposition of one joule of energy per kilogram of tissue.

however, since neutrons and alpha particles cause more damage per gray than gamma or beta radiation, another unit, the sievert (Sv) is used in setting radiological protection standards. this unit of measurement takes into account biological effects of different types of radiation. one gray of beta or gamma radiation has one sievert of biological effect, one gray of alpha particles has 20 Sv effect and one gray of neutrons is equivalent to around 10 Sv (depending on their energy). since the sievert is a relatively large value, dose to humans is normally measured in millisieverts (mSv), one-thousandth of a sievert.

the becquerel (Bq) is a unit or measure of actual radioactivity in material (as distinct from the radiation it emits, or the human dose from that), with reference to the number of nuclear disintegrations per second (1 Bq = 1 disintegration/sec). quantities of radioactive material are commonly estimated by measuring the amount of intrinsic radioactivity in becquerels – one Bq of radioactive material is that amount which has an average of one disintegration per second, i.e. an activity of 1 Bq. [31]

older units of radiation measurement continue in use in some literature:

1 gray = 100 rads

1 sievert = 100 rem

1 becquerel = 27 picocuries or 2.7 x 10-11 curies

one curie was originally the activity of one gram of radium-226, and represents 3.7 x 1010 disintegrations per second (Bq). [31]

## effects of radiation

*radiation protection standards assume that any dose of radiation, no matter how small, involves a possible risk to human health. however, available scientific evidence does not indicate any cancer risk or immediate effects at doses below 100 mSv a year. at low levels of exposure, the body's natural repair mechanisms seem to be adequate to repair radiation damage to cells soon after it occurs.*

*after the shelter was built over the destroyed reactor at Chernobyl, a team of about 15 engineers and scientists was set up to investigate the situation inside it. over several years they repeatedly entered the ruin, accumulating individual doses of up to 15,000 mSv. daily dose was mostly restricted to 50 mSv, though occasionally it was many times this. none of the men developed any symptoms of radiation sickness, but they must be considered to have a considerably increased cancer risk.*

*there is increasing evidence of beneficial effect from low-level radiation (up to about 10 mSv/yr). this 'radiation hormesis' may be due to an adaptive response by the body's cells, the same as that with other toxins at low doses. in the case of carcinogens such as ionizing radiation, the beneficial effect is seen both in lower incidence of cancer and in resistance to the effects of higher doses. However, until possible mechanisms are confirmed, uncertainty will remain. further research is under way and the debate continues. meanwhile standards for radiation exposure continue to be deliberately conservative.* [31]

*a lethal exposure of radiation ranges from 300 to 500 roentgens an hour; a microroentgen is one-millionth of a roentgen. dangers at these levels lie in long-term exposure.*[28]

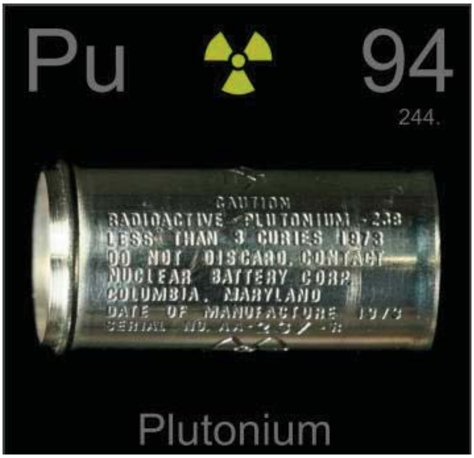
**some comparative radiation doses and their effects**[31]

| | |
|---|---|
| *2 mSv/yr* | *typical background radiation experienced by everyone (aver age 1.5 mSv in australia, 3 mSv in north america).* |
| *1.5 to 2.0 mSv/yr* | *average dose to australian uranium miners, above background and medical.* |
| *2.4 mSv/yr* | *average dose to us nuclear industry employees.* |
| *Up to 5 mSv/yr* | *typical incremental dose for aircrew in middle latitudes.* |
| *9 mSv/yr* | *exposure by airline crew flying the new york – tokyo polar route.* |
| *10 mSv/yr* | *maximum actual dose to australian uranium miners.* |
| *20 mSv/yr* | *current limit (averaged) for nuclear industry employees and uranium miners.* |
| *50 mSv/yr* | *former routine limit for nuclear industry employees. it is also the dose rate which arises from natural background levels in several places in iran, india and europe.* |
| *100 mSv/yr* | *lowest level at which any increase in cancer is clearly evident. above this, the probability of cancer occurrence (rather than the severity) increases with dose.* |
| *350 mSv/lifetime* | *criterion for relocating people after chernobyl accident.* |
| *1,000 mSv cumulative* | *would probably cause a fatal cancer many years later in 5 of every 100 persons exposed to it (i.e. if the normal incidence of fatal cancer were 25%, this dose would increase it to 30%).* |
| *1,000 mSv single dose* | *causes (temporary) radiation sickness such as nausea and de creased white blood cell count, but not death. above this, se verity of illness increases with dose.* |
| *5,000 mSv single dose* | *would kill about half those receiving it within a month.* |
| *10,000 mSv single dose* | *fatal within a few weeks.* |

radiation

*site specific*





## strontium

*atomic weight 87.62*
*density 2.63 g/cm$^3$*

*strontium-90 ($^{90}$Sr) is a radioactive isotope of strontium, with a half life of 28.8 years. natural strontium is nonradioactive and nontoxic, but $^{90}$Sr is a radioactivity hazard. together with caesium isotopes $^{134}$Cs, $^{137}$Cs, and iodine isotope $^{131}$I it was among the most important isotopes regarding health impacts after the chernobyl disaster.* [19]

## plutonium

*atomic weight 244*
*density 19.816 g/cm$^3$*

*plutonium-239 is the primary fissile isotope of plutonium used for the production of nuclear weapons, although uranium-235 has also been used and is currently the secondary isotope. plutonium-239 is also one of the three main isotopes demonstrated usable as fuel in nuclear reactors, along with uranium-235 and uranium-233. plutonium-239 has a half-life of 24,200 years.*

*the use of plutonium-239 in power plants occurs without it ever being removed from the nuclear reactor fuel because it is fissioned in the same fuel rods in which it is produced.*[10]

## cesium

*atomic weight 132.90545*
*density 1.879 g/cm$^3$*
*specific radioactivity 3.215 TBq/g (terabecquerals per gram)*

*cesium-137 ($^{137}_{55}$Cs, Cs-137) is a radioactive isotope of cesium which is formed mainly as a fission product by nuclear fission. it has a half-life of about 30.1 years, and decays by beta emission to a metastable nuclear isomer of barium-137: barium-137m ($^{137m}$Ba, Ba-137m). (about 95 percent of the nuclear decay leads to this isomer. the other 5.0 percent directly populates the ground state, which is stable.)* [4]

*radioactive cesium is not disappearing from chernobyl's environment as quickly as predicted. cesium-137's total ecological half-life--the time for half the cesium to disappear from the local environment through processes such as migration, weathering, and removal by orgranisms--is typically 30 years or less. however, scientists have calculated the ecological half-life to be between 180 and 320 years.*[22]

## chernobyl

*mass effect*

# chernobyl

*kiev, ukraine*

*51°16’20”N 30°13’27”E*

*government*
*- administration | zone of alienation*

*population (2010)*
*- total | 0*

## the site

*the history*

*as humans have been pursuing progress and civilization develops, the needs of humans have changed dramatically requiring more land, extraction of materials, and electricity to drive technology. this has inevitably led to the slow destruction of the natural environment. this is where chernobyl emerges as a significant presence.*

*the term nuclear is presented as a double-edged sword. in one sense, it is used to create the ultimate weapon of war and destruction--the other, a reaction to the speed of progess. nuclear power was needed for two reasons, one as a clean and much less destructive form of energy as opposed to fossil fuels and the other to provide power for an ever-growing and demanding population. there was, however, an unforseen incident that affected the natural environment on a global scale through the explosion of reactor no. 4. this moment became infamous as the most destructive, man-made incident on the environment in history. the incident also instilled within the human psyche a fear and paranoia of the term ‘nuclear’--a common perception that exists even today, 24 years after the 1986 explosion.*

*the existing*

*the nuclear explosion left radioactive residue through the natural and built environment surrounding the nuclear power plant complex that ultimately resulted in the establishment of a 30 kilometer exclusion zone where no permanent residence can exist. the landscape is poisoned, cities are forcefully abandoned, decaying buildings in danger of leaking more radiation into the environment endure the elements. a shell integrated with reactor no. 4 to contain radiation is falling apart existing only as an architecture of isolation. equipment used for cleanup after the explosion still emanates large amounts of radiation. special radiotrophic black fungi is growing within the reactor walls. human error manifests itself through the ‘red forest’ incident: a buried forest nearby is the most radioactive place on the planet.*

# location

*context*


*the orange parcels denote the chernobyl nuclear power plant [npp} complex. there are four reactors located here with a planned fifth and sixth. they never made it into fruition because of the 1986 explosion of reactor number 4 [denoted in yellow].*

*the red parcels denote the cities around the nuclear complex. the southernmost parcel is chernobyl. the northernmost parcel is pripyat, a city built just for the workers of the nuclear power complex.*

*located southwest of the npp complex is the 'red forest' known as the most contaminated place on the planet.*

*located east of the npp complex is a large manmade lake built exclusively for the use of the npp complex. the purpose of the lake is to provide the coolant for the reactor cores.*

*nearby is a graveyard of vehicles and helicopters used to fight chernobyl's fires. roughly 2,000 radioactive machines are parked here - fire trucks, ambulances, armored vehicles, trucks, aircraft.*[28]

*the river running adjacent to the sites is the pripyat river.*

# reactor no. 4

*the chernobyl disaster was a nuclear accident of catastrophic proportions that occurred on 26 april 1986, at the chernobyl nuclear power plant in ukraine (then in the ukrainian soviet socialist republic, part of the soviet union). it is considered the worst nuclear power plant accident in history and is the only level 7 event on the international nuclear event scale.*[7]

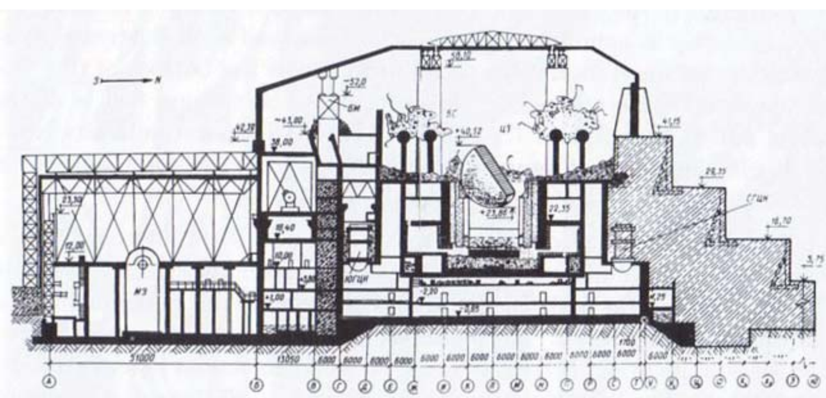


Рис. 8. Конструкция объекта «Укрытие» (сечение по оси 47):
МЗ — машинный зал; БМ — балка «Мамонт»; БС — барабаны-сепараторы; ЦЗ — центральный зал; ЮГЦН и СГЦН — соответственно южные и северные главные циркуляционные насосы

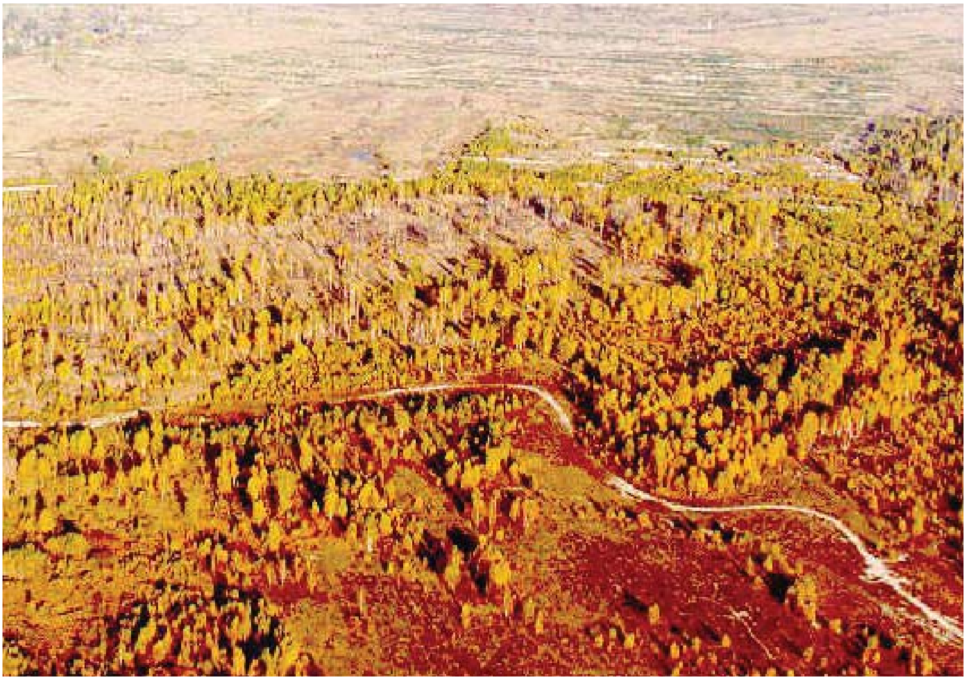
Fig. 8. Construction of the UKRITIYE (cut-away view along axis 47):
МЗ — turbine hall; БМ — «Mamont» girder; БС — drum-separators; ЦЗ — central hall; ЮГЦН и СГЦН — south and north main circulation pumps correspondingly

# lake chernobyl

*unlike many western reactors (which use the familiar cooling towers) chernobyl uses a man made lake for cooling. due to procedures used during the accident at block four the sediment at the bottom of this cooling pond is contaminated with radionuclides.*[21]

# the red forest

*according to reports from soviet scientists at the first international conference on the biological and radiological aspects of the chernobyl accident [september 1990], fallout levels in the 10 km zone around the plant were as high as 4.81 GBq/m². the so-called "red forest" of pine trees, previously known as worm wood forest and located immediately behind the reactor complex, lay within the 10 km zone and was killed off by heavy radioactive fallout. the forest is so named because in the days following the disaster the trees appeared to have a deep red hue as they died because of extremely heavy radioactive fallout. in the post-disaster cleanup operations, a majority of the 4 km² forest was bulldozed and buried. the crew dug down between 1.5 to 2 meters below ground level. inadvertently, burying the forest was one of the worst things they could have done. the contaminated residue seeped into the groundwater system, radioactively charging the site. the site of the red forest now remains one of the most contaminated areas in the world.[32]*

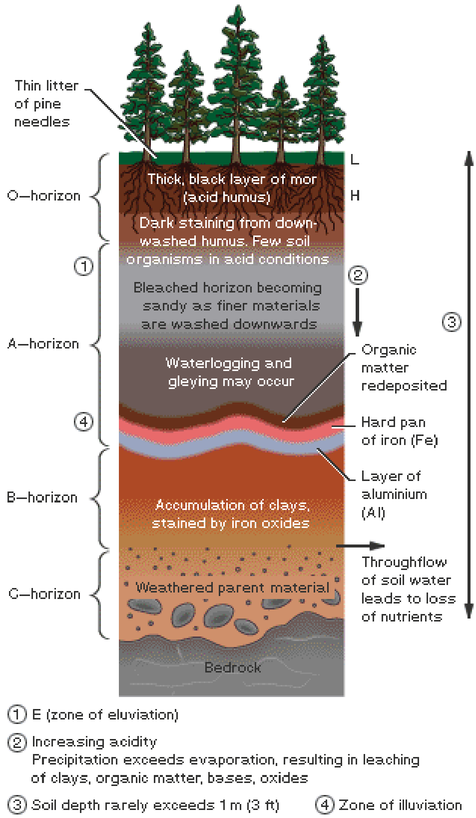


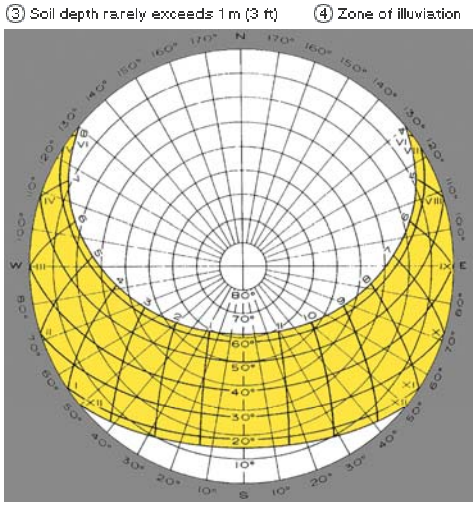
# geographical features of the exclusion zone

*the geographical zone of 'chernobyl npp 30 km exclusion zone' is within the kiev poless'e in the south part of poless'e province. this region is characterised by gradual slope from west and north-west to the east and south-east. altitude varies from 182m to 103m/ ASL. this territory is drained by pripyat, uzh, teterev rivers. extensive areas of the 'chnpp 30 km exclusion zone' are bog land.*

*climate is mild-continental with mild winter and warm summer. the presence of forests, ponds, reservoirs, bogs and settlements affect the local climatic conditions. in winter the air temperature ranges from -25 to +5 celsius, average - 6c. depth of frozen soil reaches 80 cm and the height of snow cover is 16cm. temperature ranges from 17 to 19 celsius during summer. average length of unfreezing period is approximately 160 days. annual average precipitation is near 500 cm.*

*nature of relief, maternal rocks, climatic conditions and herbage provide territory soil variety. analysis of prevailing water-glacial sediments are of sandy composition that are near river valleys, sandy grounds are changed by clay and a small reduction of relief is formed by sandy loam soils. there are podzol soils (see h in diagram on right) on the higher grounds between rivers.*[39]

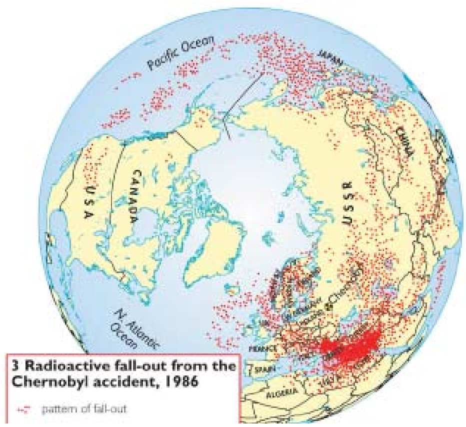


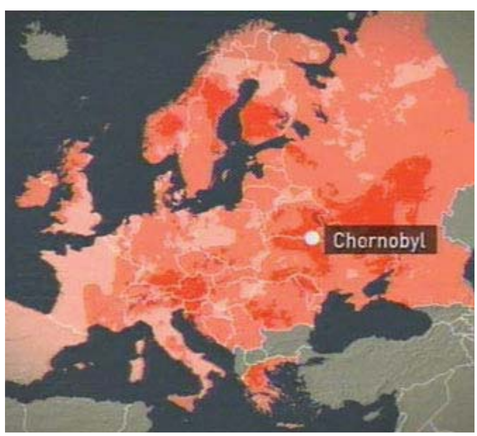



# radiation

## *global extents*

*the initial evidence that a major release of radioactive material was affecting other countries came not from soviet sources, but from sweden, where on the morning of april 28 workers at the forsmark nuclear power plant (approximately 680 mi from the chernobyl site) were found to have radioactive particles on their clothes. it was sweden's search for the source of radioactivity, after they had determined there was no leak at the swedish plant, that at noon on april 28 led to the first hint of a serious nuclear problem in the western soviet union.*[26]



*on the globe above, red indicates the extent of the radiation cloud on april 27, just after the accident in chernobyl. blue, indicates its almost worldwide distribution until the 6th of may.*

# residual radioactivity

*the current local environment*

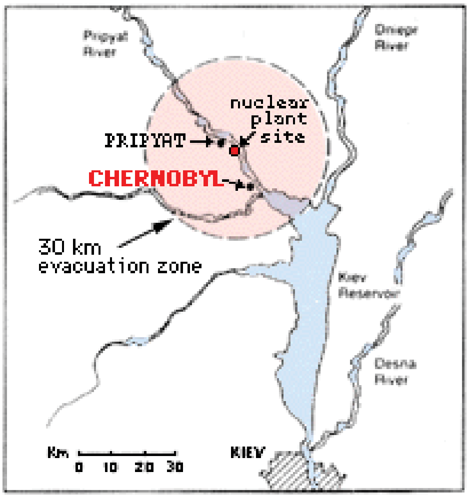
## rivers, lakes and reservoirs

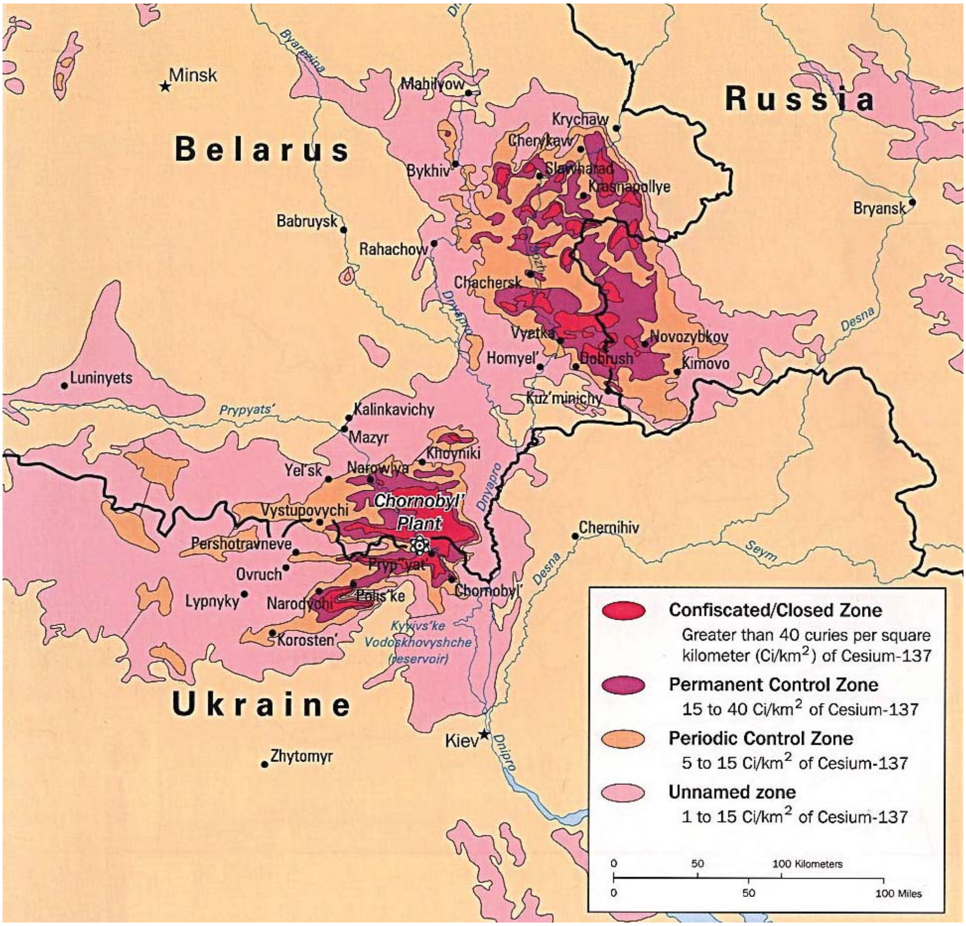
*the chernobyl nuclear power plant is located next to the pripyat river, which feeds into the dnipro river reservoir system, one of the largest surface water systems in europe. the radioactive contamination of aquatic systems therefore became a major issue in the immediate aftermath of the accident. in the most affected areas of ukraine, levels of radioactivity (particularly radioiodine: I-131, radiocaesium: Cs-137 and radiostrontium: Sr-90) in drinking water caused concern during the weeks and months after the accident. after this initial period, however, radioactivity in rivers and reservoirs was generally below guideline limits for safe drinking water.*

*bio-accumulation of radioactivity in fish resulted in concentrations (both in western europe and in the former soviet union) that in many cases were significantly above guideline maximum levels for consumption. guideline maximum levels for radiocaesium in fish vary from country to country but are approximately 1,000 Bq/kg in the european union. In the kiev reservoir in ukraine, concentrations in fish were several thousand Bq/kg during the years after the accident. In small "closed" lakes in belarus and the bryansk region of russia, concentrations in a number of fish species varied from 0.1 to 60 kBq/kg during the period 1990–92. the contamination of fish caused short-term concern in parts of the uk and germany and in the long term (years rather than months) in the affected areas of ukraine, belarus, and russia as well as in parts of scandinavia.*[7]

## groundwater

*groundwater was not badly affected by the chernobyl accident since radionuclides with short half-lives decayed away long before they could affect groundwater supplies, and longer-lived radionuclides such as radiocaesium and radiostrontium were adsorbed to surface soils before they could transfer to groundwater. however, significant transfers of radionuclides to groundwater have occurred from waste disposal sites in the 30 km (19 mi) exclusion zone around chernobyl. although there is a potential for transfer of radionuclides from these disposal sites offsite (i.e. out of the 30 km (19 mi) exclusion zone), the iaea chernobyl report argues that this is not significant in comparison to current levels of washout of surface-deposited radioactivity.*[7]






*russia, ukraine, and belarus have been burdened with the continuing and substantial decontamination and health care costs of the chernobyl accident.*

# residual radioactivity

*the current local environment*

## cesium radioisotopes

*immediately after the disaster, the main health concern involved radioactive iodine, with a half-life of eight days. today, there is concern about contamination of the soil with strontium-90 and cesium-137, which have half-lives of about 30 years. the highest levels of cesium-137 are found in the surface layers of the soil where they are absorbed by plants, insects and mushrooms, entering the local food supply. some scientists fear that radioactivity will affect the local population for the next several generations. note that cesium is not mobile in most soils because it binds to the clay minerals. recent tests (ca. 1997) have shown that cesium-137 levels in trees of the area are continuing to rise. there is some evidence that contamination is migrating into underground aquifers and closed bodies of water such as lakes and ponds (2001, Germenchuk). the main source of elimination is predicted to be natural decay of cesium-137 to stable barium-137, since runoff by rain and groundwater has been demonstrated to be negligible.*[7]

*a robot sent into the reactor itself has returned with samples of black, melanin-rich radiotrophic fungi that are growing on the reactor's walls.*[7]

## radiation levels

*the radiation levels in the worst-hit areas of the reactor building have been estimated to be 5.6 roentgens per second (R/s) (1.4 milliamperes per kilogram), which is equivalent to more than 20,000 roentgens per hour. a lethal dose is around 500 roentgens (0.13 coulombs per kilogram) over 5 hours, so in some areas, unprotected workers received fatal doses within several minutes.[24]*

| **location[7]** | **radiation (roentgens per hour)** |
|---|---|
| *vicinity of the reactor core* | *30,000* |
| *fuel fragments* | *15,000–20,000* |
| *debris heap at the place of circulation pumps* | *10,000* |
| *debris near the electrolyzers* | *5,000–15,000* |
| *water in the Level +25 feedwater room* | *5,000* |
| *level 0 of the turbine hall* | *500–15,000* |
| *area of the affected unit* | *1,000–1,500* |
| *water in Room 712* | *1,000* |
| *control room, shortly after explosion* | *3–5* |
| *gidroelektromontazh depot* | *30* |
| *nearby concrete mixing unit* | *10–15* |

# the sarcophogas 1.0

## *the object shelter*

*the existing shelter, formally referred to as the object shelter and often referred to in the vernacular as the sarcophagus, was constructed between may and november 1986 as an emergency measure to contain the radioactive materials within reactor unit 4 at the chernobyl nuclear power plant (ChNPP). The shelter was constructed under extreme conditions, with very high levels of radiation, and under extreme time constraints. the object shelter was moderately successful in containing radioactive contamination and providing for post-accident monitoring of the destroyed nuclear reactor unit.*

*the object shelter was never intended to be a permanent containment structure, despite rumors to the contrary. its continued deterioration has increased the risk of its radioactive inventory leaking out into the environment. recent upgrades to the site include pathways for roof access, roof repairs, the installation of a dust control system, and the installation of a long-term monitoring system. however, substantial upgrade or replacement of the shelter will be necessary in the near future in order to continue containing the radioactive remains of ChNPP reactor 4. it has been estimated that up to 95% of the original radioactive inventory of reactor unit 4 still remains inside the ruins of the reactor building.[7]*

# the sarcophogas 2.0

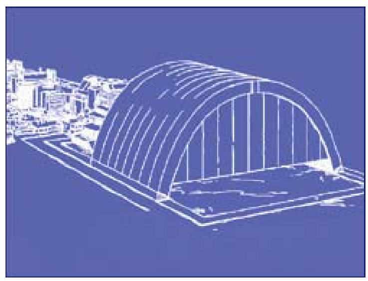
*new safe confinement [nsc]*

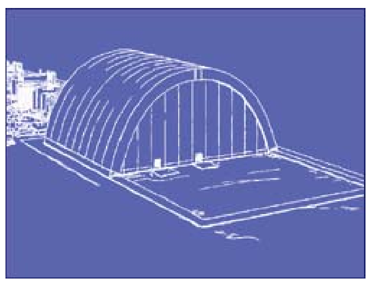
*a part of the shelter implementation plan funded by the chernobyl shelter fund, the new safe confinement or nsc is designed to contain the radioactive remains of chernobyl unit 4 for the next 100 years. it is intended to replace the present containment structure, also known as the sarcophagus or object shelter, that was hastily constructed after a "beyond design-basis accident" destroyed reactor 4 on april 26, 1986. it will be the largest movable structure ever built on earth.*

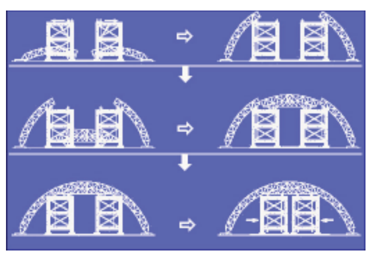
*the word "confinement" is used rather than the traditional "containment" with the intent to emphasize the difference between the "containment" of radioactive gases that is the primary focus of most reactor containment buildings, and the "confinement" of solid radioactive waste that is the primary purpose of the new safe confinement.*

*workers can only be exposed to the radioactive conditions safely for one to two months out of the year.*

*the power plant will be remotely dismantled within the new shell.[27]*





## mind | matter

*human as [explorer]*

encefuturehistorytimeeventsequencefuturehistorytimeeventsequencefuturehistorytimeeventsequence


*we are dreamers.*

*we can explore the unknown.*
*we can forsee the future.*
*we can touch the cosmos.*
*we can achieve the unobtainable.*

*we are rooted in reality.*
*we are observers of the immediate.*
*we are understanding through our senses.*
*we are inhabitants of an environment.*

*we reveal through emotion.*
*we connect with event.*
*we control a place in time.*
*we create through sequence.*

# ultio ultionis ingenium

## *the revenge of nature*

*technology has synthesized with humanity. it is inescapable. it is the harbinger of dreams. humans use technology for every means imagined: to breathe, to work, to give life, to give death, to escape our planet, to mimic the sun, to understand a world we cannot see. this very same technology manipulates the environment to achieve advancement. in many cases, humanity is destroying the very environment that it depends on--whether through pollution, extraction of resources, or destruction of ecologies, ecosystems, and environments. our roles are reversed when nature takes control of humanity and civilization.*

*times beach, missouri is an abandoned town due to the effects of human error and consequences of technology. the city commissioned the use of waste oil to control dust on unpaved streets. dioxins were spread around the area due to flooding and runoff. this toxic pollution exceeded tolerable levels forcing the city residents to evacuate the area. through human intervention [and maybe even obligation], the site has been restored into a state park system--reversing the destruction on the environment.*[35]

*centralia, pennysylvania is also abandoned due to human error and misuse of the environment. centralia was a major anthracite coal mining community. in preparation for an upcoming memorial day, firemen set fire to a garbage dump to help alleviate the smell for services occuring later. the routine event happened to backfire when a vein of underground coal caught fire. despite human effort to control the blaze, the fire continued to spread throughout the labrynth of mines. toxic gases were released forcing people to evacuate. the only solution was to let the fires burn themselves out...a solution that has been in affect for almost fifty years and still has many more to come. "centralia and its mine fire symbolize the folly of the notion that man can abuse the environment without consequence."* [5]

*the reversal of roles creates an unusual relationship between man and matter. this is where we come in. how can we use the tools we create to improve our relationship with the environment surrounding us? it is in our nature to explore the unknown or the implausible. this is how we achieve a conquering of the seemingly impossible.*

# international space station

*all for one and one for all*

*the international space station is presented here as a precedent in two ways: as pragmatic and as metaphor.*

*as a metaphor, the international space station is a symbol of progress for all humankind. it is one of the most significant as well as one of the most challenging achievements by man thusfar in history. the iss erases all human boundaries--it is built by people from every part of the planet, uniting all of humanity for one endeavor, one purpose. it is a celebration of civilization.*

*as a pragmatic, the international space station is an independent, concentrated bubble of scientists. it is a living, breathing machine, an organism, that is built for specific environmental conditions to improve humanity, civilization, technology, and the environment. it is self-sustaining and isolated. there is a sense of modularity with each pod or component infused with a specific program or function. these modules can be replaced, removed, added, or expanded as needed. although the iss is built with many pieces, they work together to become one project, one idea.*

*fundamentally, the international space station provides uninterrupted, long-term access to space allowing researchers to rapidly acquire the large sets of data necessary to validate new concepts and confirm previously unobserved phenomena. investigators are able to make multiple experiment runs in succession, building a unique exploration through long-term studies.*

*usa*

*unity*
*destiny*
*quest*
*harmony*
*tranquility*
*cupola*

*russia*

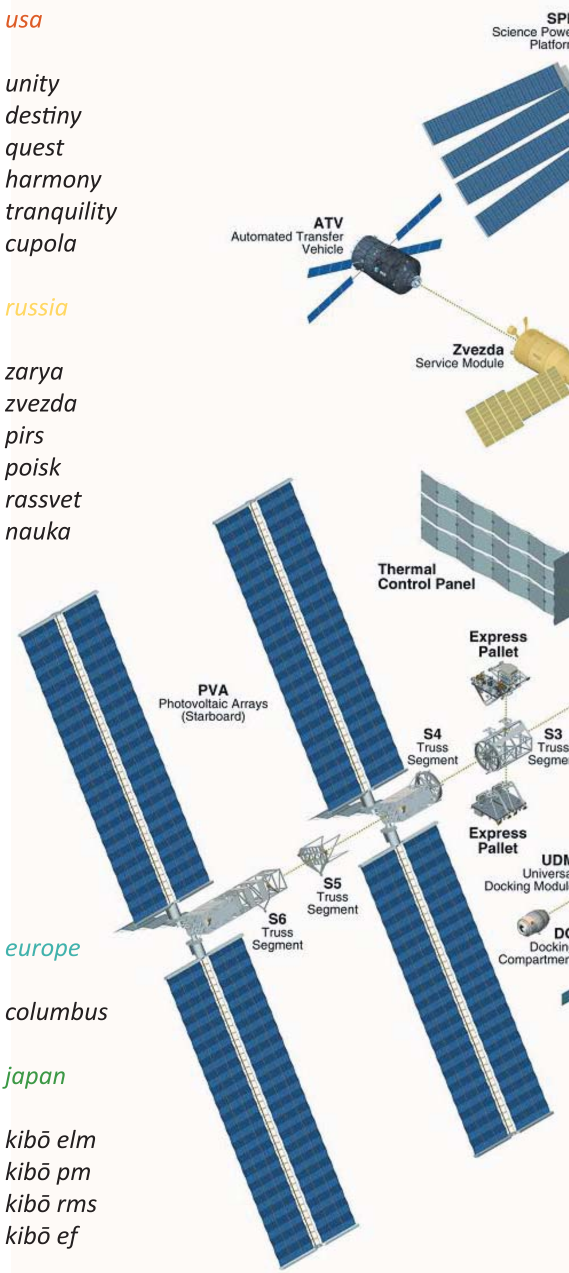
*zarya*
*zvezda*
*pirs*
*poisk*
*rassvet*
*nauka*

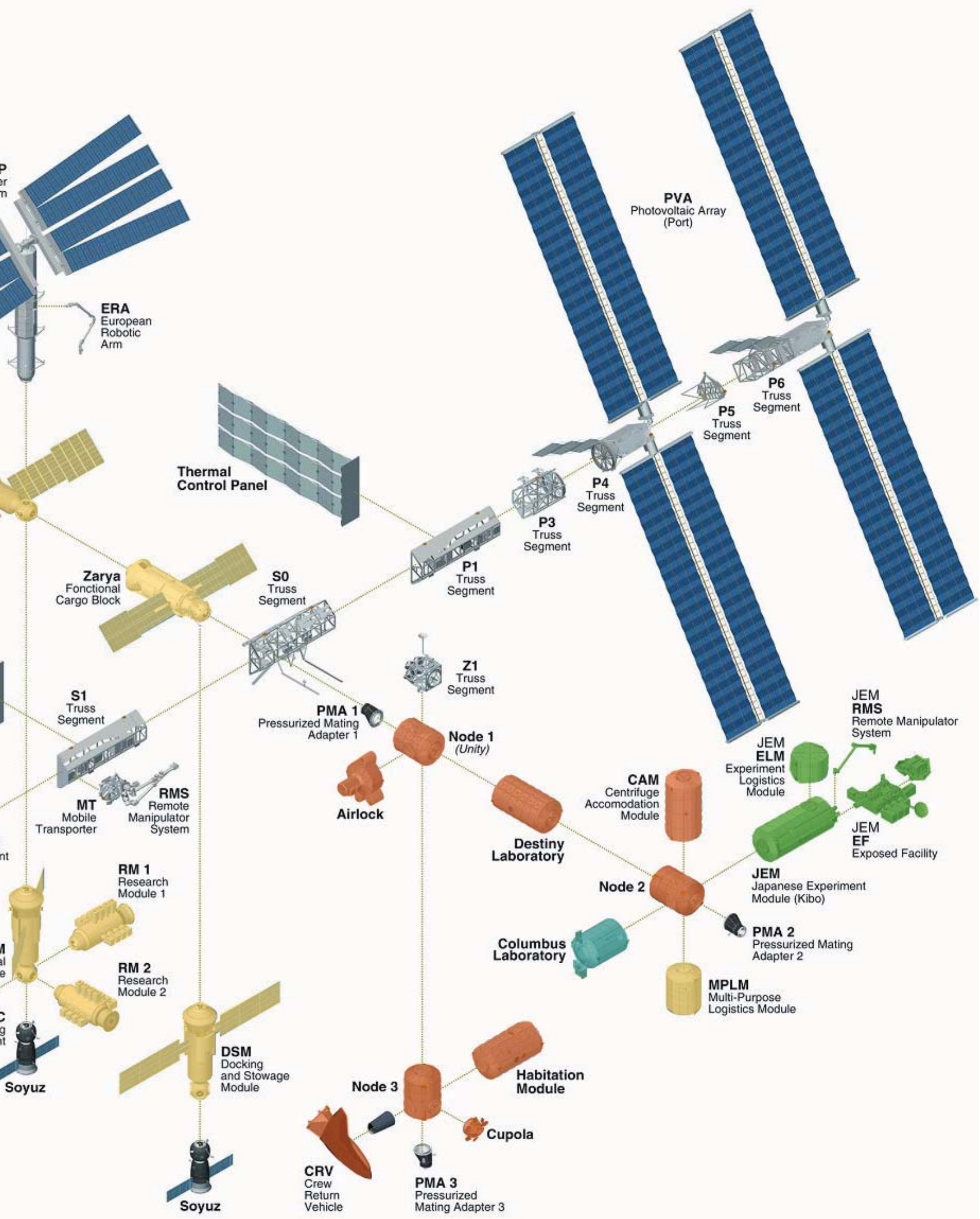
*europe*

*columbus*

*japan*

*kibō elm*
*kibō pm*
*kibō rms*
*kibō ef*




PVA
Photovoltaic Array
(Port)
ERA
European
Robotic
Arm
Thermal
Control Panel
P6
Truss
Segment
P5
Truss
Segment
P4
Truss
Segment
P3
Truss
Segment
P1
Truss
Segment
Zarya
Fonctional
Cargo Block
S0
Truss
Segment
Z1
Truss
Segment
S1
Truss
Segment
PMA 1
Pressurized Mating
Adapter 1
Node 1
(Unity)
JEM
RMS
Remote Manipulator
System
JEM
ELM
Experiment
Logistics
Module
CAM
Centrifuge
Accomodation
Module
Airlock
MT
Mobile
Transporter
RMS
Remote
Manipulator
System
Destiny
Laboratory
JEM
EF
Exposed Facility
JEM
Japanese Experiment
Module (Kibo)
Node 2
RM 1
Research
Module 1
PMA 2
Pressurized Mating
Adapter 2
Columbus
Laboratory
RM 2
Research
Module 2
MPLM
Multi-Purpose
Logistics Module
DSM
Docking
and Stowage
Module
Habitation
Module
Soyuz
Node 3
Cupola
CRV
Crew
Return
Vehicle
PMA 3
Pressurized
Mating Adapter 3
Soyuz

# the genesis project

*an overview*

# 28 years later

*the botanical research center*

### exploration

*can the damage be undone?*

*nuclear radiation from chernobyl's split-second explosions has affected environments over 100,000 miles away. the magnitude of humanity's environmental destruction is immense. but can humanity revive or remediate what they have ravaged bringing ultimate life from ultimate destruction?*

*here, a journey by six scientists has begun.*

### reflection

*isolation brought by our own hands.*

*how magnificent it is to be human. but our very own nature, our zeal for the future, is what brought us here. locked in a mental labyrinth of repetition, the sequence of decontamination, endless numbers, failed experiments...alone in this cocoon, no..this sarcophogas. our only friends: the cold, humming steel around us and the young saplings we're trying to transform to remediate this impossible environment surrounding. ones and zeros fed by veins of electrons have become our only true ways of communication. this is history we create here, even change here. we're transforming the very nature of the environment, after all.*

### synthesis

*the marriage of man and machine.*

*humanity is the driver. technology is the vessel. nuclear power requires advancements in both. but the same two protagonists that cause destruction must be used to restore. manipulation of the [already] manipulated environment could possibly restore it to what it once was or maybe even something better than the previous. man must explore science and technology in an extraordinary and atypical environment..*

*..one in which machines become the hands of the scientist.*

### response

*the birth of a synthetic landscape.*

*rows and rows of trees, orchards, ponds, fields, forests--an almost picturesque landscape that is inherently illogical. an absurd, manufactured landscape littered with radiation and poison, remnants of humanity's influence, metamorphosed by genetically altered products of nature, the lifegivers of the planet. new life created with the very same things that brought death.*

*this is the genesis project.*

# international institute of nuclear

## *genesis*

*botanical research facility*

*research labs*
*[radiation regeneration]*
*[existing conditions]*
*experimental landscape*
*[natural process]*
*[fabricated]*
*research greenhouse*
*communications*
*data storage*
*mainframes*
*recording*
*data transfer and broadcasting*
*landscape control*
*living*
*sleeping*
*dining*
*exercise*
*medical laboratory*
*aeroponics*
*controlled storage | docking station*

### *genesis project crew: 14*

- *6 botanical scientists*
  - *3 geneticists*
  - *3 plant science researchers*
- *4 botanists*
  - *2 aeroponics and research*
  - *2 experimental landscape engineering*
- *1 medical doctor*
- *1 communications technician*
- *2 information technology specialists*

## smelter

*material research facility*

*xxxxxxx*
*xxxxxx*
*xxxxxx*
*xxxxxxx*
*xxxxxxx*
*xxxxxxx*
*xxxxxx*
*xxxxxx*
*xxxxxx*
*xxxxxxx*
*xxxxxx*
*xxxxxxx*
*xxxxxxx*
*xxxxxx*

# applied sciences and advanced research

## biota

*human and animal effects research facility*

*xxxxxxx*
*xxxxxx*
*xxxxxx*
*xxxxxxx*
*xxxxxxx*
*xxxxxxx*
*xxxxxx*
*xxxxxx*
*xxxxxx*
*xxxxxxx*
*xxxxxx*
*xxxxxxx*
*xxxxxxx*
*xxxxxx*

## matter

*physics and technology research facility*

*xxxxxxx*
*xxxxxx*
*xxxxxx*
*xxxxxxx*
*xxxxxxx*
*xxxxxxx*
*xxxxxx*
*xxxxxx*
*xxxxxx*
*xxxxxxx*
*xxxxxx*
*xxxxxxx*
*xxxxxxx*
*xxxxxx*

# the genesis project

*genetus de vitae | the birth of life*

## the purpose

*the program exists with a temporal relationship to the site.*

*the past: nuclear reactor power plant complex*

*the present: botanical research center*

*the future: monument | a memory*

*the present is the program generated as a direct repercussion of the site's past program. the future program is not designed but is an inevitable result of the two former programs in its past.*

*the botanical research facility has a focus on genetic research. the premise is an experiment to alter and modify plants to be able to absorb and breakdown nuclear radiation in the environment without damaging the plants themselves. this would help remediate and restore environments that have been infected by radiation, whether it is chernobyl or nuclear bomb test sites, etc. these additions to the natural world are intended to allow the environment to restore itself [not through a direct intervention by humanity and technology but indirect]. all three variables--humanity, technology, environment--play an equal role in the experiments embarked upon by the botanical research center*

## a special condition

*in order to conduct their research, the scientists must live on site. this presents an architecture of autonomy, one that must be self-sustaining. just like the international space station, this architecture exists in a harsh environment, isolated from sustainable resources. the building must live and breathe on its own further separating it from having a connection with the site but further strengthening that same relationship at the same time [the site conditions affect the tectonics and programmatic elements]. the nature of enclosure becomes important as well. the people inhabiting the project must be well protected from the environment with the focus on the radioactive exposure. this is an architecture of survival.*

## primary program

*research labs*

*[radiation regeneration]*
*[existing conditions]*

*experimental landscape*

*[natural process]*
*[fabricated]*

*research greenhouse*

*communications*

*data storage*
*mainframes*
*recording*
*data transfer and broadcasting*
*landscape control*

*living*

*sleeping*
*dining*
*exercise*

*medical laboratory*

*aeroponics*

*controlled storage | docking station*

## the people

*6 botanical scientists*

*-3 geneticists conduct research in the existing conditions laboratories and monitor experimental landscapes*

*-3 plant science researchers conduct research in the radiation regeneration laboratories and monitor experimental landscapes*

*4 botanists*

*-2 monitor aeroponics and plant health within the research greenhouse*

*-2 oversee 'experimental landscape' engineering and research assistance in landscape*

*1 medical doctor*

*-monitor health and safety of genesis project crew as well as record health effects of exposure to radiation over time*

*1 communications technician*

*-oversees communications and digital landscape data*

*2 information technology specialists*

*-oversees instrument and computer health and operations of the modules*

**reactor no. 4**

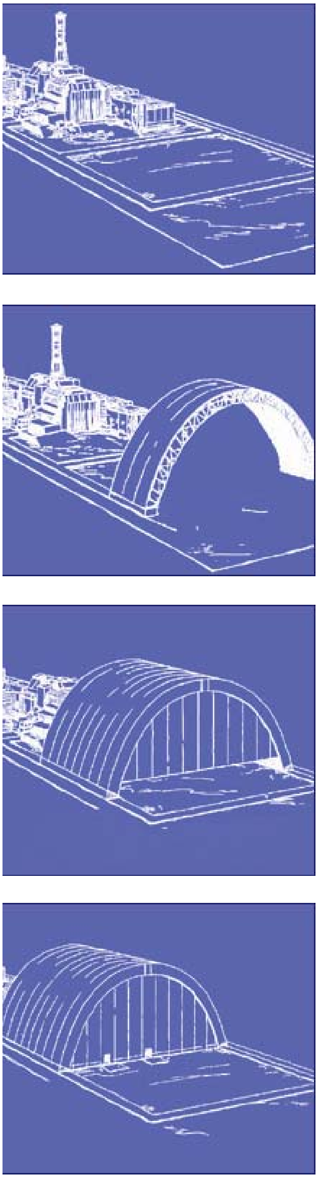
*[existing conditions]*
*remediation laboratory*

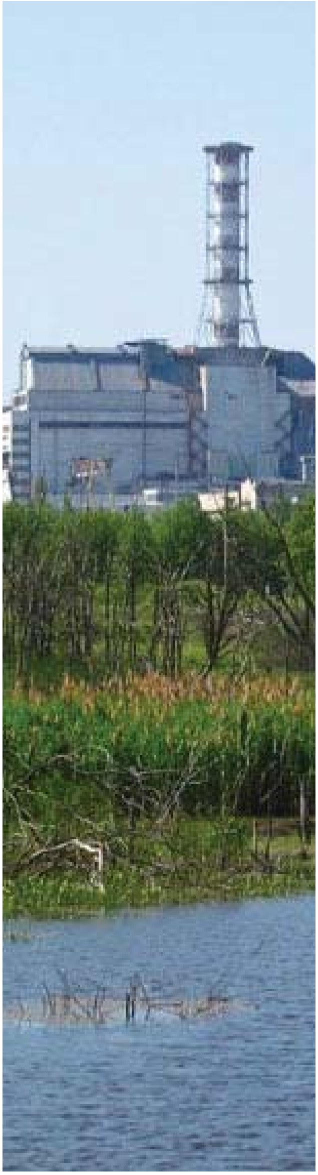
**sarcophogas 2.0**

*[radiation regeneration]*
*plant reaction laboratory*

**lake chernobyl**

*[experimental landscape]*
*natural process laboratory*





**np plant complex**

*[experimental landscape]*
*fabricated laboratory*

**the red forest**

*[experimental landscape]*
*natural process laboratory*

**chernobyl - 2**

*[international interaction]*
*communications center*

# international institute of nuclear applied sciences and advanced research

*proposed site area*

## reactor no. 4

*[existing conditions]*
*remediation laboratory*

## sarcophogas 2.0

*[radiation regeneration]*
*plant reaction laboratory*

## lake chernobyl

*[experimental landscape]*
*natural process laboratory*

## np plant complex

*[experimental landscape]*
*fabricated laboratory*

## the red forest

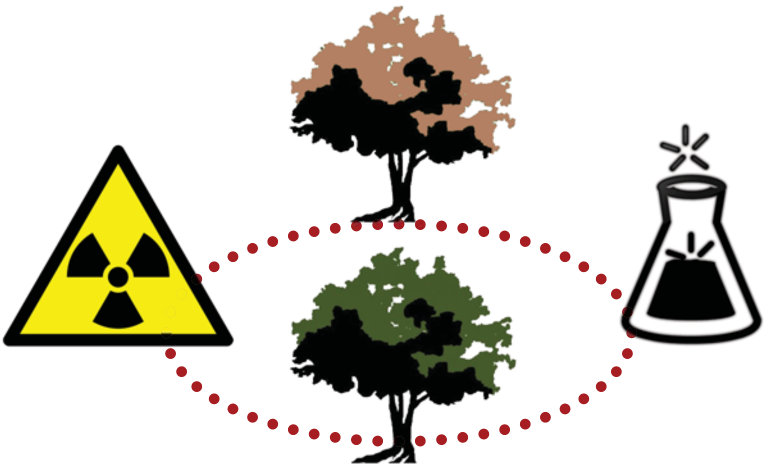
*[experimental landscape]*
*natural process laboratory*

## chernobyl - 2

*[international interaction]*
*communications center*

## the perpetual paradox

*an unhealing scar*



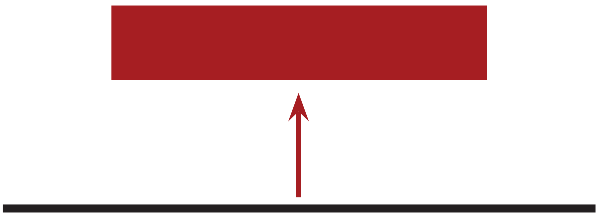
one place in the program that the nature of exposure will become most important within the proposed program is the 'radiation regeneration' laboratory. here the extreme conditions of air locks and independent air systems being required reacts to the conditions set by the program--not letting radiation seep into the environment. this specific piece of program also begins to affect how the project manifests itself and inherently brings us back to the original paradox presented in the opening statement. by perpetually creating radiation for research, the idea of autonomy is reinterpreted into more than just the building's terms--this scar created by man is continually healed and cut again. it begins to become dystopic in the sense that in order to have a greater good, we must continue to have a greater disaster--the perpetuation of creation and destruction. the entire program and site now begin to answer a question: how do we reconcile our position in the world as doing good and doing harm at the same time? this exposes the paradox presented as it is inherently--it is impossible to do purely one without the other.

## the proposed

to reinvent the use of the shell so that it does not become merely a dead entity, but to use the containment component and existing radiation to continue research to remediate the landscape creates a bubbling entity of special importance to humanity. two situations will be created inside the reinvented shell--one working with current, natural decomposition of radiation and the other constantly recreating the fresh radioactive environment. the latter requires the containment properties of the new enclosing shell.

## an architecture without a foundation

*(re)interpretation*



*"moving architecture--is this an oxymoron or a tautology? read one way it names a contradiction, read the other it states a trivial redundancy--for architecture is that which always stays still, but a building is only architecture when it is moving."*

-*wes jones,* el segundo

*the building program now emerges from these conditions using technology to manipulate the environment once again--nuclear power is achieved through a manipulation of the natural elements--in order to remediate the effects from 28 years before. however, the site begins to exhibit certain problems for a building that are defacto and unchangeable. the existing ground cannot be disturbed or can only be done so minimally in order to prevent the re-release of radiation laying dormant in the soil. the question that is now being addressed is how to construct a building in a place that you cannot construct a building in any traditional sense. the paradox emerges here: the creation of an architecture that has little physical connection to the site [cannot 'touch' it], but at the same time is extremely site specific and can only exist in the impossible conditions. this will be revealed in the tectonics and building language presented. for example, this building without a foundation--a reversal of one of the most important things physically and psychologically for a building to exist--will become a mobile machine creating a minimal connection to the ground. what is interesting here is that the project is trying to do no harm to a radioactive landscape, a landscape of destruction. this relationship presents several more requirements. one is the idea of transience. the architecture begins to be perceived as temporary even though it would be designed to last much longer than a traditional building is thought to last [some radioactive isotopes are not acting as predicted and are expecting to be extended from 30 years to between 180 and 320 years], another paradox. prefabricated modules could be used, expanded, or replaced as necessary. parts of the building, like smaller laboratories, would manifest themselves as mobile objects continuing the premise of transience and its relationship to site conditions.*

# familiar unfamiliar

*“while the objects around me...were but matters to which, or to such as which, i had been accustomed from my infancy--while i hesitated not to acknowledge how familiar was all this--i still wondered to find how unfamiliar were the fancies which ordinary images were stirring up.”*

*-edgar allan poe,* the fall of the house of usher

*though it is strongly rooted in the realm of engineering with its pragmatic and highly scientific program, the project becomes architectural in how it responds to the uniquely specific site conditions and the effect this has on the users' experience of the project. now the narratives of the project crew become the important factor driving the architecture. the proposed site is not normative, so no standard typologies can apply here. this inherently transforms the way spaces are interpreted and even provides spaces and programs that are not included within the typical building realms: the experience of going to work; the decontamination rooms, airlocks, and checkpoints as regular thresholds; the sleeping and living areas; the exercise and recreational areas; the way research is conducted and the roles technology and environment have in that research; the experience of going on break; the experience of food and water production; the spatial sequence combining the program pieces together; the connection and disconnection with the forests, lakes, animals, cities, and fields immediately surrounding the facility complex. In essence, the project takes pieces of program that can be found anywhere taken for granted as being very normal and reinterprets them as something completely different because of unchangeable site conditions. however, to the crew it would be regarded as normal--a return to comfort from paranoia:*

*"we will examine...images of rest, of refuge, of rootedness....the house, the stomach, the cave, for example, carry the same overall theme of the return to the mother. in this realm the unconscious commands, the unconscious directs."*

*-gaston bachelard,* la terre et les reveries du repos

# mobile hospital

*building in transience*

*a new hospital typology has been designed by the team of hord coplan macht + spevco that eliminates the need for a standard hospital. in their design, 58 trailers provide a fully operational, fully mobile 48-bed hospital.  the trailers include every aspect of a hospital – from waiting gift shops, to surgical suites with 4 O.R.s, pharmacies and labs. the design is the future of how westernized health care will travel abroad. it is a system that effectively transforms health care for entire regions and countries over time, letting the hospital and care come to the patient.*

*different trailers cater to different medical needs. for instance, a single unit trailer (or 5-unit suites) would be specifically oriented to some aspect of patient care, such as a women's health clinic. this 5-unit clinic could be shut down in one location, mobilized, and re-opened in about 2 to 3 days. thus, it would serve as an outreach model for major health care systems.*

*other trailers may be outfitted for an imaging suite (including resources to perform an mri, mammography, ct scan and x-ray scanning, with a supporting nurse station and waiting area), a mobile health clinic (for general health care including blood draw stations) and even an emergency suite (complete with 2 trauma bays with 8 urgent care beds and an ambulance bay to expand emergency care services for existing facilities).[25]*

*monarch systems mobile hospital[25]:*

| | |
|---|---|
| *overall healthcare facility* | *55,380 sf* |
| *entry lobby, waiting, gift shop* | *3,015 sf* |
| *on-call suite* | *5,025 sf* |

*- includes mens and womens shower units, mens and womens on-call rooms, and a doctor's lounge.*

| | |
|---|---|
| *cafeteria, kitchen and servery* | *4,020 sf* |

*- does not include 2,190 SF dining patio.*

| | |
|---|---|
| *acute care in-patient services* | *10,050sf* |

*- services 48 patient beds.*

| | |
|---|---|
| *emergency department* | *5,025 sf* |

*- includes two trauma bays, and 8 urgent care beds.*

| | |
|---|---|
| *pharmacy* | *1,005 sf* |
| *administration/admitting* | *2,010 sf* |
| *labs/phlebotomy* | *2,010 sf* |
| *icu suite* | *3,015 sf* |

*- includes 8 patient beds.*

| | |
|---|---|
| *imaging suite* | *5,025 sf* |

*- includes an mri, ct scan, mammo., and x-ray (radiology).*

| | |
|---|---|
| *surgical suite* | *7,035 sf* |

*- includes 4 O.R.s, 4 pre-op beds and 4 recovery beds.*

| | |
|---|---|
| *materials mgmt / central sterile* | *3,845 sf* |
| *ambulance entry* | *725 sf* |
| *restricted corridor* | *1,245 sf* |
| *public corridors* | *2,330 sf* |

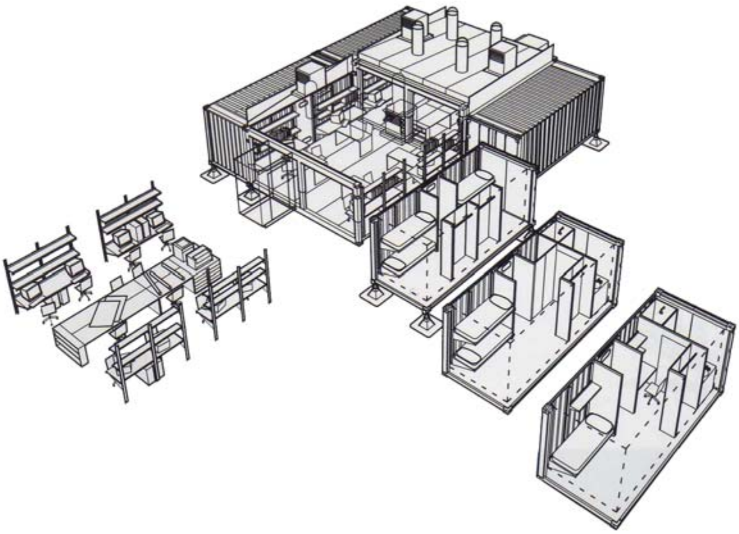
*total unit count:*

*50 double expandable units*
*1 single expandable unit*
*7 linkage corridors.*

# u.s. army transportation command

*secure remote temporary modular housing*

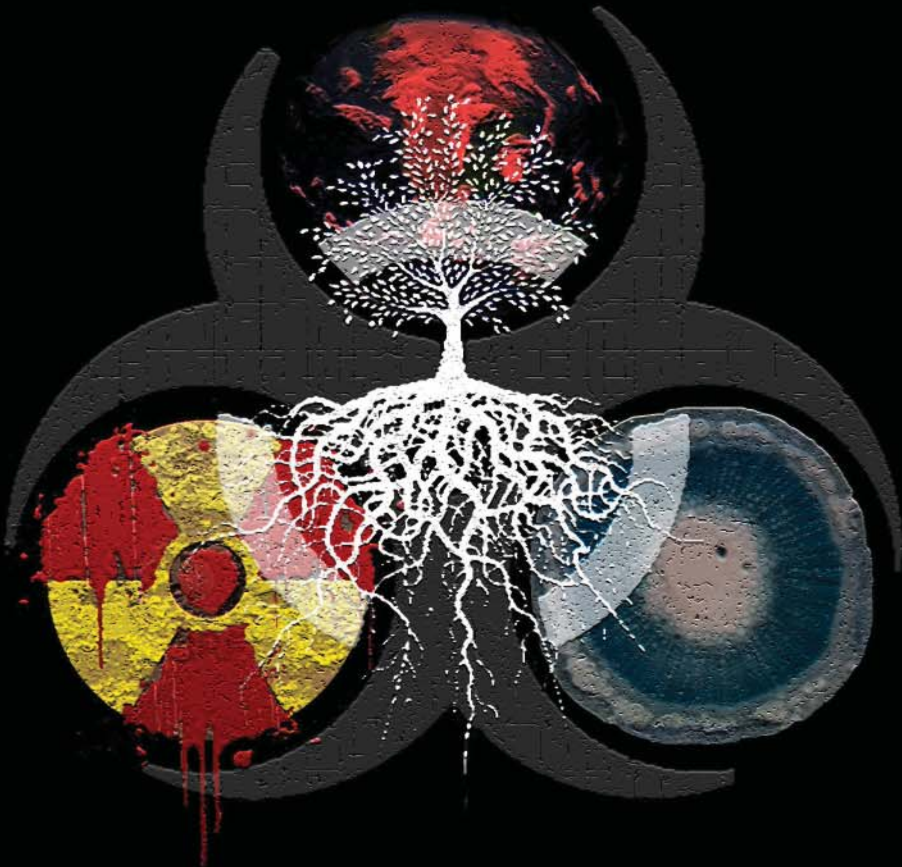
*the pro/con system is adapted here to the specialized needs of the u.s. military--in particular the housing of civilian contractors (engineers) in remote, inhospitable sites. the container at the heart of the pro/con system is built to withstand tremendous abuse, but was never intended to face the sort of environment it might face in service in afghanistan or iraq. the modified pro/con system addresses this problem in several ways. an additional layer of thin plate steel is added on the inside face of the insulation, for example, which acts together with the container's own walls like spaced armor, to dissipate the energy of projectiles between the two layers. the panels that clad the larger workspaces (between the containers) are similarly constructed as a steel/foam sandwich. additionally, all exterior windows are eliminated and exterior doors are equipped with armored vestibules. escape hatches are located in the floor of each pro/con unit. grenade skirts protect the crawl space beneath the structure (to which the escape hatches lead) when the structure is set on its leveling jacks. a parasol/sunshade structure doubling as a grenade screen is provided over the whole installation. steps taken to compensate for the lack of exterior vision/view, in the interests of the quality-of-life of the (civilian) occupants, might include bullet-proof vision slits or virtual periscope-type windows using offset mirrors and fiber-optic 'skylights.'[20]*




B1
B1/AE 62

# genesis

*program brief*



*module one|two [experimental landscape]*

| | |
|---|---|
| *laboratory* | *250 sq ft* |
| *office* | *100 sq ft* |
| *write-up area* | *25 sq ft* |
| *decontamination* | *100 sq ft* |
| *lockers* | *12 sq ft* |
| *corridor* | *variable* |
| *docking vestibule* | *25 sq ft* |
| *cockpit* | *25 sq ft* |
| *auxiliary living* | *150 sq ft* |
| *restroom* | *25 sq ft* |
| *storage* | *50 sq ft* |
| *it room* | *25 sq ft* |
| *mechanical* | *200 sq ft* |
| *atv dock* | *50 sq ft* |
| *experimental landscape* | *variable* |
| *total sq ft* | *1037 sq ft* |
| *gross sq ft* | *1300 sq ft* |

*module three [aquatic research]*

| | |
|---|---|
| *laboratory* | *250 sq ft* |
| *office* | *100 sq ft* |
| *write-up area* | *25 sq ft* |
| *decontamination* | *100 sq ft* |
| *lockers* | *12 sq ft* |
| *corridor* | *variable* |
| *docking vestibule* | *25 sq ft* |
| *cockpit* | *25 sq ft* |
| *depressurization chamber* | *50 sq ft* |
| *auxiliary living* | *150 sq ft* |
| *restroom* | *25 sq ft* |
| *storage* | *50 sq ft* |
| *it room* | *25 sq ft* |
| *mechanical* | *200 sq ft* |
| *total sq ft* | *1037 sq ft* |
| *gross sq ft* | *1300 sq ft* |

*module six [medical laboratory]*

| | |
|---|---|
| *operating room* | *100 sq ft* |
| *write-up area* | *25 sq ft* |
| *office* | *100 sq ft* |
| *prep room* | *25 sq ft* |
| *recovery room* | *100 sq ft* |
| *auxiliary living* | *150 sq ft* |
| *decontamination* | *100 sq ft* |
| *lockers* | *12 sq ft* |
| *it room* | *25 sq ft* |
| *restroom* | *25 sq ft* |
| *corridor* | *variable* |
| *docking vestibule* | *25 sq ft* |
| *cockpit* | *25 sq ft* |
| *mechanical* | *200 sq ft* |
| *atv dock* | *50 sq ft* |
| *total sq ft* | *962 sq ft* |
| *gross sq ft* | *1200 sq ft* |

*module seven [communications]*

| | |
|---|---|
| *data storage\|mainframes* | *75 sq ft* |
| *data transfer\|broadcasting* | *25 sq ft* |
| *landscape control* | *25 sq ft* |
| *office* | *100 sq ft* |
| *meeting room* | *150 sq ft* |
| *decontamination* | *100 sq ft* |
| *docking vestibule* | *25 sq ft* |
| *it room* | *25 sq ft* |
| *restroom* | *25 sq ft* |
| *corridor* | *variable* |
| *storage* | *100 sq ft* |
| *atv dock* | *50 sq ft* |
| *total sq ft* | *700 sq ft* |
| *gross sq ft* | *875 sq ft* |

*module four [sustainability]*

| | |
|---|---|
| research greenhouse | 500 sq ft |
| aeroponics | 250 sq ft |
| hydroponics | 250 sq ft |
| office | 100 sq ft |
| write-up area | 25 sq ft |
| decontamination | 100 sq ft |
| lockers | 12 sq ft |
| corridor | variable |
| docking vestibule | 25 sq ft |
| cockpit | 25 sq ft |
| restroom | 25 sq ft |
| storage | 100 sq ft |
| it room | 25 sq ft |
| mechanical | 200 sq ft |
| atv dock | 50 sq ft |
| total sq ft | 1687 sq ft |
| gross sq ft | 2100 sq ft |

*module five [living]*

| | |
|---|---|
| sleeping area | 500 sq ft |
| dining area | 300 sq ft |
| kitchen | 150 sq ft |
| restrooms | 150 sq ft |
| lockers | 50 sq ft |
| exercise room | 450 sq ft |
| recreation room | 450 sq ft |
| common area | 300 sq ft |
| conference room | 300 sq ft |
| it room | 25 sq ft |
| medical lab (small) | 100 sq ft |
| decontamination | 100 sq ft |
| corridor | variable |
| docking vestibule | 25 sq ft |
| cockpit | 25 sq ft |
| storage | 150 sq ft |
| mechanical | 200 sq ft |
| atv dock | 75 sq ft |
| total sq ft | 3350 sq ft |
| gross sq ft | 4200 sq ft |

*module eight [existing conditions lab]*

| | |
|---|---|
| laboratory | 2500 sq ft |
| office | 100 sq ft |
| write-up area | 25 sq ft |
| decontamination | 100 sq ft |
| lockers | 12 sq ft |
| corridor | variable |
| docking vestibule | 25 sq ft |
| auxiliary living | 150 sq ft |
| restroom | 25 sq ft |
| storage | 200 sq ft |
| it room | 25 sq ft |
| mechanical | 200 sq ft |
| atv dock | 50 sq ft |
| total sq ft | 3412 sq ft |
| gross sq ft | 4265 sq ft |

*module nine [radiation regeneration lab]*

| | |
|---|---|
| laboratory | 5000 sq ft |
| office | 100 sq ft |
| write-up area | 25 sq ft |
| decontamination | 100 sq ft |
| lockers | 12 sq ft |
| corridor | variable |
| docking vestibule | 25 sq ft |
| auxiliary living | 150 sq ft |
| restroom | 25 sq ft |
| storage | 200 sq ft |
| it room | 25 sq ft |
| mechanical | 300 sq ft |
| atv dock | 50 sq ft |
| total sq ft | 6012 sq ft |
| gross sq ft | 7500 sq ft |

**environmental sciences division**

*an ornl workshop report*

*the genesis project will be continuing research started by the oak ridge national laboratory, ornl, and the international atomic energy agency, iaea; it will also attempt to expand and reinterpret many facets of the research for better understanding of how plant biota react to radiation. many of the parameters and guidelines established by the agencies for the effects of ionizing radiation on terrestrial plants (evergreens, deciduous trees, shrubs/grasses, aquatic plants) will become the foundations for the research of the genesis project crew and the unique laboratory facilities. those parameters will also aid in determining safety precautions for the design of the laboratory and living spaces. presented here is a distillation of the ornl workshop report prepared for the u.s. department of energy office of environmental policy and assistance| air, water, and radiation division.*

## *summary of the iaea report*

*the focus of the iaea was on defining standards that would protect the viability of populations of organisms, even though some individuals might be adversely affected. the report considered two types of exposures to populations. an acute exposure is one that is delivered in a time period that is short compared with the time over which any obvious biological response develops. a chronic exposure is one that could continue over a large fraction of the natural life of the organism. both experimental (laboratory and field) and observational (areas of high natural background radiation and areas with significant anthropogenic contamination) studies were evaluated.*

*in addition to estimating a 'safe' dose for biota, iaea evaluated whether application of current radiological protection standards for human exposure would result in maintenance of doses to biota below the 'safe' level. three exposure scenarios were evaluated:*

- *controlled releases of radionuclides from the atmosphere*
- *controlled releases of radionuclides to a freshwater aquatic system*
- *and uncontrolled constant releases of radionuclides from a shallow-land nuclear waste repository*

*for each scenario, steady-state environmental concentrations of selected radionuclides were calculated that would yield a radiation dose to man equal to the annual dose limit for members of the public (1 mSv/year). these concentrations were used to calculate equilibrium dose rates to reproductive or growth tissues of aquatic and terrestrial biota. the resulting doses were compared with the 'safe' does rates (1 rad/d for aquatic biota and 0.1 rad/d for terrestrial biota) recommended by the group. parameter selection emphasized situations that would yield maximum environmental concentrations and therefore maximum doses to biota. evaluations of doses to plant tissue considered foliar depositions, root uptake, and external exposure. effects also examined extensive tree mortality in pine forests near chernobyl.*

*approximate dose-response relationships can be derived from studies of 'acute' effects of radiation at kyshtym (i.e., effects resulting from the first 1 to 1.5 years of exposure following the 1957 explosion of stored radioactive waste):*

- *where dose rates exceeded 300-500 rad/d at the soil surface (deposition 4000 Ci/km$^2$ $^{90}$Sr), complete mortality of even the most tolerant plant species (e.g., species with renewal buds below the soil surface) occurred.*
- *where dose rates exceeded 40-50 rad/d at the soil surface, complete mortality of grasses and herbs with renewal buds at or near the surface occurred. these plants were replaced by plants with renewal buds buried in the soil. slow recovery occurred after 3-4 years.*
- *where dose rates to the meristem buds of birch trees exceeded 40-50 rad/d ($^{90}$Sr deposition 4000 Ci/km$^2$), mortality to trees was complete. at lower dose rates, withered crowns, underdeveloped leaves, and phenological shifts (delay in opening of leaves and flowers, premature leaf fall) were observed over 4 years.*
- *where dose rates at the soil surface were less than or equal to 30 rad/d, seed germination was reduced in plants with renewal buds near the soil surface; morphological changes (gigantism, chlorosis, blued and contorted leaves, lower numbers of seeds in spikes) were observed in some species over 2-3 years.*
- *pine trees were the most sensitive of the biota examined. where dose rates to needles were 5-10 rad/d or higher, complete mortality of pines occurred within 2 years. at lower dose rates, a variety of sublethal effects were observed. [2]*

## laboratory studies | biological effects data

*participants first identified the types of laboratory data that could be used in setting radiological protection standards. the following types of effects were discussed:*

- *chromosomal aberrations, defined as visually observable morphological changes in chromosome structure;*
- *dna damage, defined as damage to dna molecules, detectable through biochemical assays;*
- *growth reduction, defined as a reduction in the rate of growth of organisms, including both animals and plants;*
- *reproduction effects, including sterility, reduction in fecundity, and occurrence of developmental abnormalities or reduction in viability of offspring;*
- *reduced seed germination in plants;*
- *mortality, including both acute lethality and long-term reduction in life span.*

*most laboratory research on radiation effects on plants has been performed with seeds and seedlings. the range of sensitivities of species and life stages in nature is undoubtedly much greater than the range of sensitivities of species and life stages for which laboratory data are available. workshop participants compiled a list of criteria for evaluating published laboratory studies:*

- *duration. chronic studies, defined as studies in which organisms are exposed throughout most or all of their life spans, are preferred over acute studies.*

- *replication. studies should include sufficient replication for confidence limits around test endpoints such as ld50s to be reliably calculated.*
- *taxonomic distribution. studies covering a wide range of taxa are preferable to those covering a narrow range.*
- *ecological relevance of endpoints. only test endpoints that have clear consequences for the abundance and persistence of populations should be considered. these endpoints include growth, reproduction, and survival.* [2]

*field studies*

*the general consensus of participants was that field data are usually more valuable than laboratory data for assessing ecological effects of ionizing radiation. two kinds of field studies have been performed: experimental studies, in which natural ecosystems have been exposed to radiation under controlled conditions, and monitoring studies, in which measurements of radiation exposures and effects have been made in contaminated environments. the conditions in experimental studies are much more natural than in laboratory studies. the full array of natural biota are potentially available for study. for plants, population-level effects can be directly observed. indirect effects, notably changes in plant community composition caused by reduced abundance of sensitive plant species, can also be observed.*

*monitoring of contaminated ecosystems has additional advantages. many such sites involve exposures over a much larger spatial scale than is possible in a field experiment. sites where data relevant to radiological protection standards have been collected include mayak, kyshtym, chernobyl, windscale, the doe reservations, nuclear-weapons testing sites throughout the world, uranium-mining sites, and regions with high natural background radiation. whereas experimental studies have used primarily acute external exposures, monitoring studies involve both internal and external exposures and, in many cases, chronic exposures. with certain limitations in mind, workshop participants developed a list of criteria for selection of field studies for use in standard setting:*

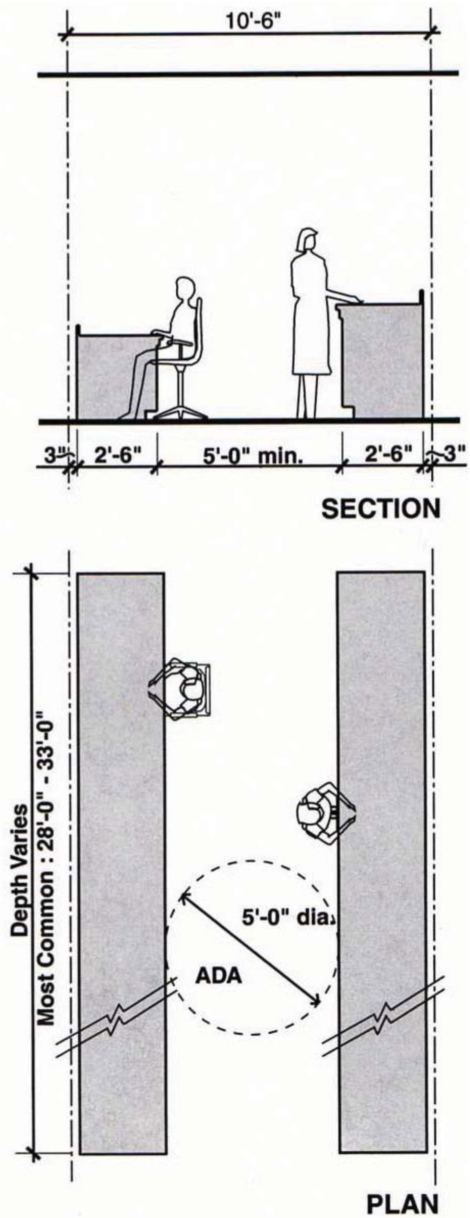
- *duration. long-term studies are preferable to short-term; this criterion applies both to the duration of the dose and the duration of the study.*
- *presence of dose-response relationship. the magnitude of the measured response should increase with increasing radiation dose; intermediate responses as well as high responses and negative responses should be observed.*
- *type of effect observed. demonstrations of impacts on populations and communities are more useful than measurements of impacts on individual organisms.*

*chronic studies were preferred over acute studies.*[2]

**bl-3**

*safezone*

*there exist several highly specific design issues and constraints concerning research laboratory configurations. however, there are general recommendations that are most efficient for design that allow the most flexibility in adjusting or expanding the modules and for accomodating equipment and control systems. the following pages will define the module system, spatial and technical requirements, and safety requirements.*

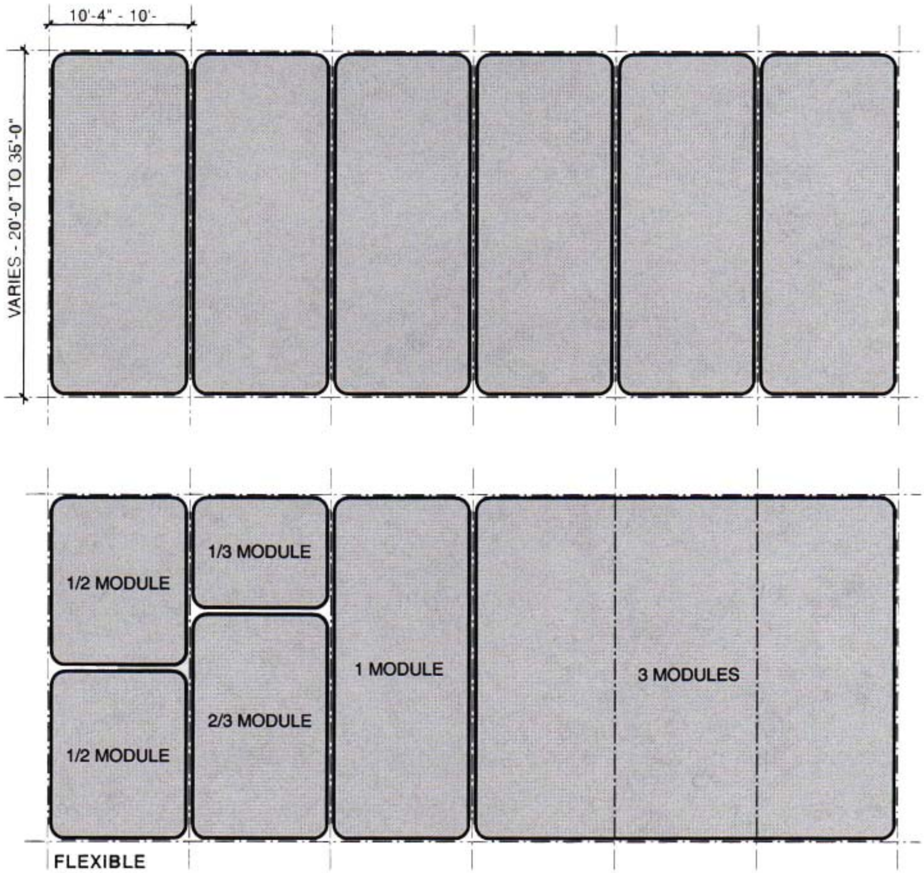



## *basic lab module*

*a common laboratory module has a width of approximately 10' 6" but will vary in depth from 20' to 33'. the depth is based on the size necessary for the lab and the cost-effectiveness of the structural system. the 10' 6" dimension is based on two rows of casework and equipment (each row 2' 6" deep) on each wall, a 5' aisle, and 6" for the wall thickness that separates one lab from another. the 5' aisle width should be considered a minimum because of the requirements of the americans with disabilities act (ada) and to allow one researcher to pass another without interference. the 10'4" module should be fine for a building with labs that comprise at least two lab modules. the 10'8" module should be considered if there are several small labs that will require only one lab module.[38]*

## *ceiling height*

*the standard 9'6" ceiling height is recommended for most labs. with this height, there is enough space for the use of indirect light fixtures. some labs may need to be two stories high to accommodate large equipment or specific research processes. no lab should have a ceiling height below 8'. [38]*




## *lab doors*

*the recommended minimum door width for a lab is 38", but a 42" door is preferred. double doors or doors with active and passive panels may be useful. glazing in the doors should be considered for most labs. there should always be two means of egress from a laboratory area where hazardous chemicals are present.* [38]

## *aisles*

*aisles between workstations should measure at least 5' to permit a person to pass behind another person who is working. aisles wider than 6' are not recommended for most labs, because users tend to clutter the space with carts and equipment. workstations should be staggered back-to-back to allow people to work more easily.* [38]

*offices*

*researchers spend approximately half of their time in the lab and the other half in their offices. offices can get cluttered very quickly, and designing a visually successful office therefore not only involves the quality and quantity of furniture and the amount of glazing, but also space-related issues such as the ability to work on a computer and to meet with other people comfortably, and the amount of shelving and other storage.* [38]

*write-up areas*

*in addition to researchers' offices, most facilities have write-up areas within or immediately adjacent to the lab. for safety reasons, always avoid placing a write-up station behind or near a fume hood.* [38]

*note: write-up stations will also include the video apparatus for scientific log recording.*

*overhead service carriers*

*an overhead service carrier is hung from the underside of the structural roof system. the utility services are run above the ceiling, where they are connected to the overhead service carrier. these services should have quick connect and disconnect features for easy hookups to the overhead service carriers. overhead service carriers come in standard widths and accommodate electrical and communication outlets, light fixtures, service fixtures for process piping, and exhaust snorkels.* [38]

*docking stations*

*floor-mounted docking stations can include all utility feeds and a sink.* [38]

*mobile casework*

*mobile carts make excellent equipment storage units. often used in research labs as computer workstations, mobile carts allow computer hardware to be stacked and then moved to equipment stations as needed. data ports are also located adjacent to electrical outlets along the casework. carts are typically designed to fit through a 3 ft wide doorway and are equipped with levelers and castors. many mobile carts are load tested to support 2000 lb.* [38]

*note: for mobile laboratories, a unique pneumatic suspension (air ride) workbench that protects analytical equipment from the constant vibration of transport is available. additionally, there are custom load locks that are used to ensure analytical equipment stays in place on the workbench while in transit.*

*fume hoods*

*a fume hood, the prime protection device in a laboratory, should be used when a researcher is:*

- *working with chemicals known or suspected to be hazardous*
- *working with unknown substances*
- *pouring, mixing, weighing, or dispensing chemicals*

*to minimize risk in the event of an explosion, hoods should be located on outside walls whenever possible. standard sizes are 4', 5', 6', and 8' for hoods that are 2'6" deep. fume hoods should be placed as far away from write-up areas if possible and preferrably situated away from doors.* [38]

# safety

## *precautionary procedure*

*the maximum annual dose allowed for radiation workers is 20 mSv/yr, though in practice, doses are usually kept well below this level. there are four ways in which people are protected from identified radiation sources:*

- *limiting time. in occupational situations, dose is reduced by limiting exposure time.*
- *distance. the intensity of radiation decreases with distance from its source.*
- *shielding. barriers of lead, concrete or water give good protection from high levels of penetrating radiation such as gamma rays. intensely radioactive materials are therefore often stored or handled under water, or by remote control in rooms constructed of thick concrete or lined with lead.*
- *containment. highly radioactive materials are confined and kept out of the workplace and environment. nuclear reactors operate within closed systems with multiple barriers which keep the radioactive materials contained.* [38]

### *general safety principles*

*for safety and ease of maintenance, it usually makes sense to locate a safety shower, fire extinguisher, and shutoff valves at the entry alcove of each lab. warning signs with the appropriate symbols should be posted at laboratory entrances. there should be two means of egress from each main lab (labs measuring 900 sq ft or more). doors should swing out of main labs for safe egress in case of emergency.*

*in most cases, labs should be organized with the highest hazards (e.g., fume hoods) farthest from the entry door and the least hazardous elements (e.g., write-up stations) closest to the door. write-up desks and benches should be accessible without having to cross in front of fume hoods. all lab users should be trained in emergency procedures.*

*appropriate casework should be provided: islands are preferable to peninsulas, since*

| BIOLOGICAL SAFETY CABINETS | | | | |
|---|---|---|---|---|
| Type | Face Velocity (ft per min) | Airflow Pattern | Radionuclides/Toxic Chemicals | Biosafety |
| Class I | 75 | In at front; rear and top through HEPA filter | No | 2, 3 |
| Class II Type A | 75 | 70% recirculated through HEPA filter, exhaust through HEPA filter | No | 2, 3 |
| Class II | 100 | 30% recirculated through HEPA; exhaust via HEPA and hard ducted | Yes (low levels/volatility) | 2, 3 |
| Class II Type B1 | 100 | No recirculation; total exhaust via HEPA and hard ducted | Yes | 2, 3 |
| Class II Type B2 | 100 | Same as IIA, but plenum under negative pressure to room and exhaust air is ducted | Yes | 2, 3 |
| Class III Type B3 | N/A | Supply air inlets and exhaust through two filters, HEPA | | 3, 4 |

*islands allow people to walk around benches. personal items and clothing should be kept in lockers outside the lab area. most labs are required to be under negative pressure relative to the corridor. floor penetrations should be avoided, if possible, to prevent chemicals released during a spill or flood from traveling below. [161-2] in any lab where shelving is used to store chemicals, the shelves should be no higher than eye level.* [38]

*chemicals must be handled locally in the lab or with dilution tanks in or near the building.* [38]

## safety showers and eyewashes

*safety showers should never be farther than 100' away from any researcher, along a clear and unobstructed path (75' is recommended). safety showers are usually placed in the corridor, highly visible from the lab exits, and should include an eyewash. putting a floor drain under the shower is not recommended. a floor drain may create contamination problems in the drain piping. it is better to allow the chemicals at the shower to be mopped up in order to identify what was on the individual.* [38]

## glove boxes

*glove boxes are airtight, sealed on all sides, and operated through gloves.* [38]

## biological safety cabinets

*biological safety cabinets are intended to protect the researcher from harmful agents inside the cabinet, to protect the research, and to protect the environment from contaminants. all biological safety cabinets have a hepa filter to remove particles and aerosols from the air.* [38]

**EXEMPT AMOUNTS OF HAZARDOUS MATERIALS PRESENTING A HEALTH HAZARD (MAXIMUM QUANTITIES PER CONTROL AREA)**

| Material | Storage[b] | | | Closed Systems[b] | | | Open Systems[b] | |
|---|---|---|---|---|---|---|---|---|
| | Solids (lb)[cd] | Liquid (gal or lb)[cd] | Gases (cu ft) | Solids (lb)[c] | Liquid (gal or lb)[c] | Gases (cu ft) | Solids (lb)[c] | Liquid (gal or lb)[c] |
| Corrosive | 5,000 | 500 | 810[cd] | 5,000 | 500 | 810[cd] | 1,000 | 100 |
| Highly Toxic | 1 | (1) | 20[e] | 1 | (1) | 20[e] | 1/4 | (1/4) |
| Irritant | 5,000 | 500 | 810[cd] | 5,000 | 500 | 810[cd] | 1,000 | 100 |
| Radioactive | 25 rem, unsealed | | | 100 rem, sealed sources | | | 25 rem, sealed source | |
| Sensitize | 5,000 | 500 | 810[cd] | 5,000 | 500 | 810[cd] | 1,000 | 100 |
| Toxic | 500 | (500) | 810[cd] | 500 | (500) | 810[cd] | 125 | (125) |
| Other Health Hazards | 5,000 | 500 | 810[cd] | 5,000 | 500 | 810[cd] | 1,000 | 100 |

# biosafety level 3 (bl-3)

*precautionary procedure*

*bl-3 labs are designed to contain the agents used within them. design issues include the following:*

- *bl-3 spaces must be accessible only through a controlled entrance. for obvious safety reasons, the general public and nonessential lab personnel must not be allowed to enter.*
- *bl-3 spaces should be under negative pressure with respect to adjacent areas. if the pressure is compromised, an automatic alarm should sound.*
- *liquid-resistant finishes are recommended for walls, floors, and ceilings.*
- *any windows in the bl-3 area must be sealed shut.*
- *each bl-3 module should have near the exit a hand-washing sink that operates automatically, by foot, or by elbow.*
- *because of the possibility of contamination, lab furniture must be easily cleanable.*
- *spaces between furniture and equipment must be easily reached for cleaning.*
- *work surfaces must be impervious to water and resistant to organic solvents, acids, bases, and heat. stainless-steel surfaces are recommended.* [38]

**RECOMMENDED BIOSAFETY LEVELS FOR INFECTIOUS AGENTS**

| Biosafety Level | Agents | Practices | Safety Equipment (Primary Barriers) | Facilities (Secondary Barriers) |
|---|---|---|---|---|
| 1 | Not known to cause disease in healthy adults. | Standard microbiological practices | None required | Open bench top sink required<br>Basic |
| 2 | Associated with human disease<br>Hazard: auto-inoculation, ingestion, mucous membrane exposure | BSL-1 practice plus: limited access; biohazard warning signs; "sharps" precautions; biosafety manual defining any needed waste decontamination or medical surveillance policies | Primary barriers: Class I or II BSCs or other physical containment devices used for all manipulations of agents that cause splashes or aerosols of infectious materials;<br>PPEs: laboratory coats;gloves; face protection as needed | BSL-1 plus: autoclave available<br>Basic |
| 3 | Indigenous or exotic agents with potential for aerosol transmission; disease may have serious or lethal consequences | BSL-2 practice plus: controlled access; decontamination of all waste; decontamination of lab clothing before laundering; daseline serum | Primary barriers: Class I or II BSCs or other physical containment devices used for all manipulations of agents<br>PPEs: protective lab clothing; gloves; respiratory protection as needed | BSL-2 plus: physical separation from access corridors; self-closing, double door access; exhausted air not recirculated; negative airflow into laboratory containment |
| 4 | Dangerous/exotic agents which pose high risk of life-threatening disease, aerosol-transmitted lab infections, or related agents with unknown risk of transmission | BSL-3 practices plus: clothing change before entering; shower on exit; all material decontaminated on exit from facility | Primary barriers: all procedures conducted in Class III BSCs or Class I or II BSCs in combination with full-body, air-supplied, positive pressure personnel suit | BSL-3 plus: separate building or isolated zone; dedicated supply/exhaust, vacuum, and decon system; other requirements outlined in the text<br>Maximum containment |

## metamorphosis

*human as [resurrector]*

*we have the power to destroy.*

*we have the power to restore.*

*[we have the power to revive.]*

# redemptio clementia

*the redemption of humanity*

*what does the future hold for humanity? by observing history and current human relationships with the environment, we can use technology to become aware of impending issues and restore a harmonious interaction and relationship with the environment. this relationship must be regenerative in nature and must be a synthesis of humanity, technology, and the environment.*

## a future of the past

*the unintentional monument*

*finally, the silence and emptiness contributed the aura of a tomb.*

*-anthony vidler*

# time in memory

## *the last trace*

*rome is only a vast museum; pompeii is living antiquity.....a roman town conserved in its entirety, as if its inhabitants had just left a quarter of an hour before.* [37]

*pompeii possessed a level of archaeological verisimilitude matched by historical drama that made of it the perfect vehicle, in a century obsessed by the fugitive relations between past and future, what theophile gautier--a full-blown romantic--variously called "l'amour retrospectif." the special characteristic of this retrospective vision was its unsettling merging of past and present, its insistence on the rights of the unburied dead, its pervasive force over the fates of its subjects.*[37]

*the idea of history suspended, the past restored in the present, that is the future of chernobyl. a parallel inherently exists with the resurfacing of the city of pompeii. one is able to understand the site as it once existed because of a catastophic explosion rendering the site uninhabitable. pompeii was essentially 'frozen' in time and rediscoved just like an old photograph.*

*mobile architecture preserves the chernobyl site as it lay from previous events. precautions to unique radioactive site conditions--30 km exclusion zone, new safe confinement, radioactive soil, etc.--allow the site an unhindered existance. what remains tells the story of the history--the last trace is the future of the past.*

# chernobyl

*mass effect$^{2.0}$*

*the program*

*research is no longer needed. the facility is abandoned, though not empty. the technology and machines used to conduct the botanical research as well as the ruined machinery from the reactor remain inside the shell still eminating vast amounts of radiation. technology has now become a casualty. the building encloses a tomb for this defunct, however advanced technology. the research modules have been re-located and re-adapted to other sites.*

*the site*

*the shell protrudes from a forest of experimental plants. there is no formal activity occuring on site except that of visiting. the site is now a monument, not created as a formal memory, but a result of a technical necessity and programmatic requirement of years past. though new plants can break down radiation in the environment, the machines and technology can only be disassembled--left for natural processes of the earth to take back control.*

*the people*

*humanity understands the research and history that once existed on site through the video logs of the scientists and the landscapes that now exist throughout the world attempting to remediate other nuclear contamination sites. oral tradition and books chronicle the history of the site and the memory that it holds.*

# appendix of equipment

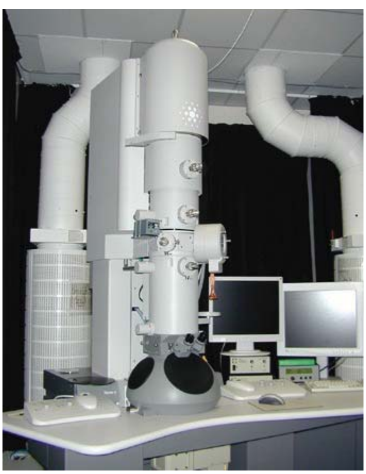
*fixed equipment*

| *equipment item* | *typical size* | *description and comments* |
|---|---|---|
| *autoclave medium chamber* | *24x36x35”* | *an autoclave is a device to sterilize equipment and supplies by subjecting them to high pressure saturated steam at 121 °C or more, typically for 15-20 minutes depending on the size of the load and the contents.[1]*<br><br>*note: usually located in the wash area. electric service, steam, and a floor drain are necessary.[38]* |


| | | |
|---|---|---|
| *biological safety cabinet* | *varies* | *biological safety cabinets are intended to protect the researcher from harmful agents inside the cabinet, to protect the research, and to protect the environment from contaminants.[3]* |

| equipment item | typical size | description and comments |
|---|---|---|
| *dishwasher* | *30x30x36”* | *a dishwasher is a mechanical device for cleaning dishes and utensils.*[11]<br><br>*note: a lab dishwasher is similar to a residential dishwasher, but permits higher temperature and deionized water to be used for lab supplies.* [38] |

| | | |
|---|---|---|
| *electron microscope* | *10x14’* | *an electron microscope is a type of microscope that produces an electronically-magnified image of a specimen for detailed observation. the electron microscope (em) uses a particle beam of electrons to illuminate the specimen and create a magnified image of it.*[12]<br><br>*note: size and services vary. usually has its own transformer, which should be located outside the electron microscope room. cooling water may be required. cold water, floor drain, exhaust, relative humidity control, and magnetic and mechanical isolation are factors that must be addressed. room must be able to be blacked out.* [38] |



| equipment item | typical size | description and comments |
|---|---|---|
| flow cytometer | 84x60” | a flow cytometer is similar to a microscope, except that, instead of producing an image of the cell, flow cytometry offers “high-throughput” (for a large number of cells) automated quantification of set parameters.[13]<br><br>note: usually located in a separate lab, in a biological safety cabinet if the cells to be separated are possibly pathogen infected.[38] |

| equipment item | typical size | description and comments |
|---|---|---|
| fume hood | 48, 72 or 96 x 32”x varies | a fume hood or fume cupboard is a type of local ventilation device that is designed to limit exposure to hazardous or noxious fumes, vapors or dusts.[15] |

| equipment item | typical size | description and comments |
| --- | --- | --- |
| glass washer<br>glassware dryer | 42x40x90” | may be interchangeable with dishwasher. [11]<br><br>note: usually located in a central wash-up room. a purified water supply, compressed air supply, and floor drain will be necessary. [38] |

| | | |
| --- | --- | --- |
| mainframe computer | varies | mainframes are powerful computers used mainly by large organizations for critical applications, typically bulk data processing.[23]<br><br>note: mainframes require more space, more supporting structure, and ventilation for cooling purposes. |

| equipment item | typical size | description and comments |
|---|---|---|
| mri (magnetic resonance imaging) | varies | an mri is a medical imaging technique used in radiology to visualize detailed internal structures. [38]<br><br>note: electric service, cold water, exhaust, humidity and temperature control are typically required. [38] |


| | | |
|---|---|---|
| operating table | 104x26"x varies | an operating table is the table on which the patient lies during a surgical operation or other procedure.[29]<br><br>note: must be well lit and able to manuever. |

| equipment item | typical size | description and comments |
| --- | --- | --- |
| overhead service carrier | varies | an overhead service carrier is hung from the underside of the structural roof system. the utility services are run above the ceiling, where they are connected to the overhead service carrier. these services should have quick connect and disconnect features for easy hookups to the overhead service carriers. overhead service carriers come in standard widths and accommodate electrical and communication outlets, light fixtures, service fixtures for process piping, and exhaust snorkels. [38] |

# appendix of equipment

*moveable equipment*

| equipment item | typical size | description and comments |
|---|---|---|
| aeroponics structure | varies | aeroponics is the process of growing plants in an air or mist environment without the use of soil or an aggregate medium which negates the risk of transplant shock. aeroponics uses one-tenth, even as little as one-twentieth, of the water otherwise necessary to grow the crop.[18]<br><br>note: ideally, the environment is kept free from pests and disease so that the plants may grow healthier and quicker than plants grown in a medium. controlled environments advance plant development, health, growth, flowering and fruiting for any given plant species and cultivars. due to the sensitivity of root systems aeroponics is often combined with conventional hydroponics which is used as an emergency “crop saver” - backup nutrition and water supply - if the aeroponic apparatus fails.[18] |

| equipment item | typical size | description and comments |
|---|---|---|
| alpha-beta-gamma geiger counter | 40x25x21” or varies/handheld | a geiger counter is a type of particle detector that measures ionizing radiation.[16] |

| equipment item | typical size | description and comments |
| --- | --- | --- |
| centrifuge | varies/tabletop | a centrifuge is a piece of equipment that puts an object in rotation around a fixed axis, applying a force perpendicular to the axis. the centrifuge works using the sedimentation principle, where the centripetal acceleration causes more dense substances to separate out along the radial direction; lighter objects will tend to move to the top. [6]<br><br>note: sizes can vary, but most larger units can be accommodated in a space 4’ wide x 3’ deep. ultracentrifuges may need cold water and a floor drain. they are usually run under continuous vacuum. [38] |


| | | |
| --- | --- | --- |
| computers and printers | varies | a computer is a programmable machine that receives input, stores and manipulates data, and provides output in a useful format.[9] |

| equipment item | typical size | description and comments |
|---|---|---|
| glove box | varies | glove boxes are airtight, sealed on all sides, and operated through gloves.[17] note: a glove box is not a chemical fume hood. [38] |

| | | |
|---|---|---|
| lyophilizer | 48x30x48” | a lyophilizer (freeze-dryer) uses a dehydration process typically used to preserve a perishable material or make the material more convenient for transport. Freeze-drying works by freezing the material and then reducing the surrounding pressure and adding enough heat to allow the frozen water in the material to sublime directly from the solid phase to the gas phase.[14] |

| equipment item | typical size | description and comments |
|---|---|---|
| mobile casework | varies/carts to tables | mobile carts make excellent equipment storage units. often used in research labs as computer workstations, mobile carts allow computer hardware to be stacked and then moved to equipment stations as needed. data ports are also located adjacent to electrical outlets along the casework. carts are typically designed to fit through a 3 ft wide doorway and are equipped with levelers and castors. many mobile carts are load tested to support 2000 lb. [38] |

| | | |
|---|---|---|
| refrigerator | 34x36x84” | a refrigerator is a cooling apparatus that comprises a thermally insulated compartment and a heat pump—chemical or mechanical means—to transfer heat from it to the external environment (i.e., the room in which it is located), cooling the contents to a temperature below ambient.[33]<br><br>note: used mainly for medical purposes. |

| equipment item | typical size | description and comments |
|---|---|---|
| *scintillation counter* | *36x34x26”* | *a scintillation counter measures ionizing radiation.[34]*<br><br>*note: may be bench mounted or floor standing. [38]* |

| equipment item | typical size | description and comments |
|---|---|---|
| *vacuum pump* | *10x18x20”* | *a vacuum pump is a device that removes gas molecules from a sealed volume in order to leave behind a partial vacuum.[36]* |

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*dedicated to the researchers, administrators, facility engineers, fellow architects, and engineers who strive each day to create better research environments, and thus contribute to new scientific discoveries that improve the quality of all our lives.*


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