black hat USA 2023

AUGUST 9-10, 2023

BRIEFINGS

Seeing Through The Invisible

Radiation Spikes Detected In Chernobyl During The Russian Invasion Show Possible Evidence Of Fabrication

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www.reversemode.com

Seeing Through the Invisible:
Radiation Spikes Detected in Chernobyl During the Russian Invasion Show Possible Evidence of Fabrication

1. CONTEXT

Black hat USA 2017

GO NUCLEAR: BREAKING RADIATION MONITORING DEVICES

PRESENTED BY

Ruben Santamarta

‘Radiation leak’ attack scenario

4. Attackers prepare the dataset of falsified readings that they want to transmit to simulate a radiation leak. Before sending these measurements, attackers may decide to perform a Denial-of-Service (DoS) against the legitimate WRM2-capable devices, by interfering at the right moment with the frames being sent. Malicious actors can launch this attack as the Digi's XSC FHSS hopping pattern is known and timings can be calculated. Instead of using this previous DoS step, attackers may directly transmit their falsified readings, which will be collected by the base transceiver and transmitted to the software that processes this data.

[1] https://www.blackhat.com/docs/us-17/wednesday/us-17-Santamarta-Go-Nuclear-Breaking%20Radition-Monitoring-Devices-wp.pdf

February 2022

REUTERS

Europe

Ukraine reports higher Chernobyl radiation after Russians capture plant

FRANCE 24

Ukraine sees radiation spike in Chernobyl after Russia attack

Forbes

BREAKING

Chernobyl Radiation Levels Rose After Russia's Seizure, Ukraine Says

The Washington Post

Europe

Ukraine says Chernobyl radiation levels 'exceeded,' as Russia confirms its forces seized the nuclear plant

BBC

Chernobyl: Why radiation levels spiked at nuclear plant

A year ago

Hi Ruben- Would like to talk about radiation monitoring network anomalies in Ukraine. Could be an exploitation of a hack similar to what you described previously.

France's IRSN – Technical Malfunction –

Asked by *20 Minutes* , the French Institute for Radiation Protection and Nuclear Safety (IRSN) is not able to explain this difference in readings: "We tried to understand what could justify this increase in dose rate on the beacons, we haven't really found a coherent explanation", admits Karine Herviou, Deputy Director General in charge of nuclear safety at IRSN.

However, it is worth noting the large discrepancies in the measurements available in the area: some stations detected increases but others did not, and all suffered data transmission interruptions (the cause of which is unknown) lasting for several hours.

In view of the elements at its disposal, and without ruling out the hypothesis that radioactive material was put back in suspension by the nearby passage of heavy military equipment, the explanation preferred by IRSN is a technical malfunction of these stations. This analysis is supported by IRSN's technical discussions with its international partners and the International Atomic Energy Agency (IAEA). The latter also indicated, in a press release issued by its Director General on 28 February 2022[7], that the data at its disposal, communicated by the Ukrainian safety authority (State Nuclear Regulatory Inspectorate of Ukraine - SNRIU), indicated levels of radioactivity consistent with the background noise usually observed in the area.

Academic paper

Chornobyl radiation spikes are not due to military vehicles disturbing soil

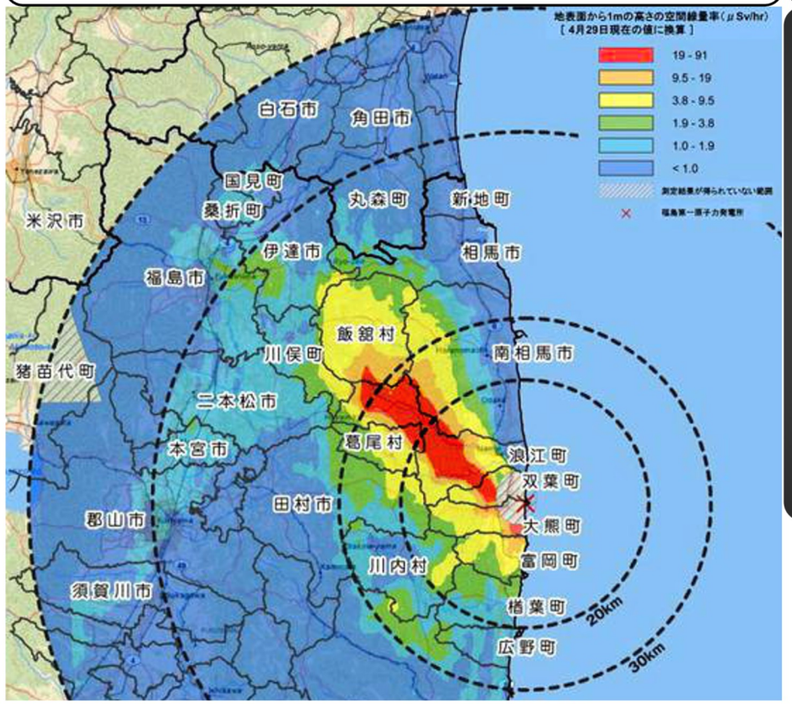
Michael D. Wood, Nicholas A. Beresford, Catherine L. Barnett, Peter H. Burgess, Shelly Mobbs

We have determined that spikes in dose rates were recorded by 39 of the 66 operational CRMS detectors on 24th and/or 25th February (coinciding with the Russian invasion); three of these are located to the south, outside of the CEZ (Figure 2). All detectors subsequently went offline, although not all at the same time and for different time periods. After the spike dose rate, 30 of the detectors went offline immediately and the remaining nine rapidly returned to baseline dose rate readings (within 30 min to 3 h after the spike) before also going offline. A detector in the CEZ that is part of a

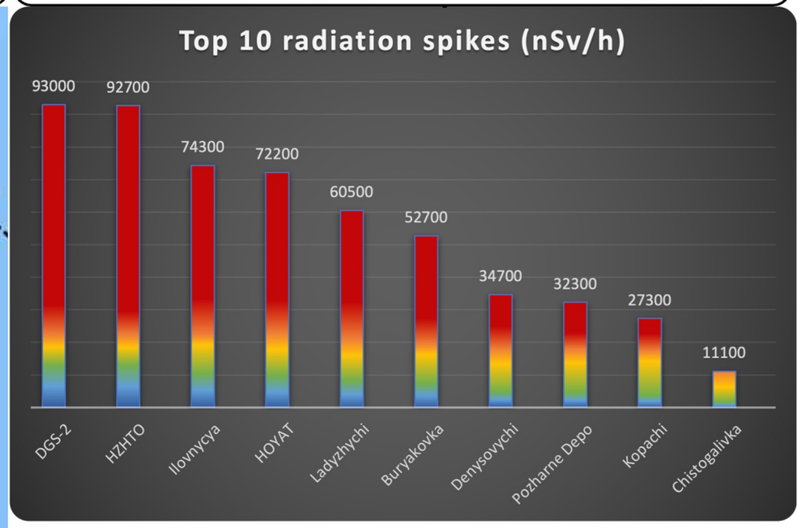
https://arxiv.org/abs/2204.03157

Worst radiological event after Fukushima

Fukushima - 2011
H*(10) one month after the accident



Chernobyl Exclusion Zone - 2022
H*(10) due to traffic induced dust resuspension



Ambient Equivalent Dose Rate (H*(10)) - max value

93 µSv/h - Chernobyl Exclusion Zone

91 µSv/h - Fukushima

36 years after the explosion of Reactor IV in Chernobyl, the ‘DGS-2’ radiation monitoring station allegedly detected a spike of 93000 nSv/h (93 µSv/h). On the other hand, just one month after the accident the highest peak within an 80-km radius area around Fukushima Daiichi NPP (excluding the levels within the NPP area) was 91000 nSv/h (91 µSv/h).

What this research is about

- This is data-driven research, conceived to be impartially verified, regardless of subjective claims or specific interests. The scope of the events under consideration is basically comprised of well-known physical processes and a series of deterministic behaviors derived from modern digital electronics.

- My opinion is irrelevant, the only important aspect of this research is that all the data herein presented can be independently verified by anyone willing to do so.

- The sole purpose of this research is to provide sufficient technical evidence to allow it to be used as part of a rigorous assessment of the radiation spikes, detected in the CEZ, during the first forty-eight hours of the Russian invasion.

- The evidence herein presented has been collected by different means, including OSINT, hardware and software reverse engineering, and data analysis of the radiation levels scraped from the Ecocentre website by www.saveecobot.com during the 24th and 25th of February 2022.

- **Read the paper, 40 minutes are not enough.**

2. PHYSICAL

My mind

Reality

April 2020 – Checkpoint Leliv

Engulfed by an intense smoke plume.

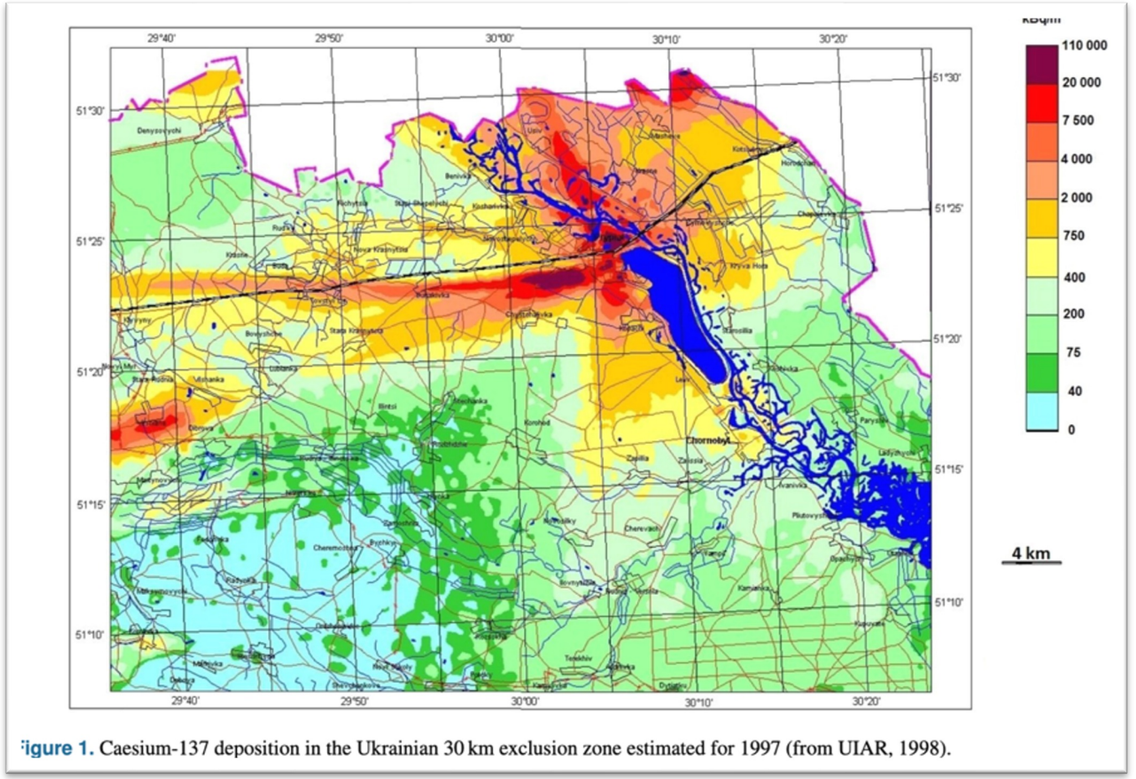
Feb 2022 – Checkpoint Leliv

During the Russian invasion.

The same radiation monitoring network that detected radiation spikes during the invasion, allegedly due to resuspension of radioactive dust, did not report any during these wildfires.

1986 - Chernobyl Accident

- The explosion of Reactor IV, and subsequent fires, released approximately 5% of the reactor core radioactive materials into the atmosphere in the form of aerosols, gases and fragmented fuel.
- Radioactive materials eventually settled onto the ground following different paths and directions due to winds and other climatological conditions present at that time
- Scientists performed a massive undertaking in an effort to map this process.
- Comprehensive deposition maps of the Chernobyl Exclusion Zone.
- Generate these maps according to the ^{137}Cs decay for an arbitrary year.
- The resuspension of radioactive materials present in the soil is not a homogenous process across the CEZ.



igure 1. Caesium-137 deposition in the Ukrainian 30 km exclusion zone estimated for 1997 (from UIAR, 1998).

Resuspension

- Intuitively, and empirically, we know that by driving on a dry, unpaved road we will stir up more dust than in doing so over a damp, paved surface, but there should be an approach to validate that this conclusion is scientifically valid.

- The analysis of the scientific literature on this topic shows that any research into these kinds of anthropogenic activities partially relies on an empirical approach: the characterization of the soil, climatological conditions, the type of vehicle and its speed…all of them contribute to the ability of resuspending radioactive materials.

- One of the most complete papers on this topic to date (published in 1996) is ‘Contamination of Surfaces by Resuspended Material’ . It was a joint effort by the European Commission, Belarus, the Russian Federation and Ukraine

- Certain conclusions expressed in this paper, which are corroborated by other scientific publications, are crucial to understanding the problem.

Transport

8.4.2 Anthropogenic resuspension

The anthropogenic measurements were used to derive line source strengths. The conclusion we can draw is that anthropogenic resuspension is negligible compared to natural resuspension as far as transport is concerned. However, from the occupational point of view it is far more important for tractor drivers.

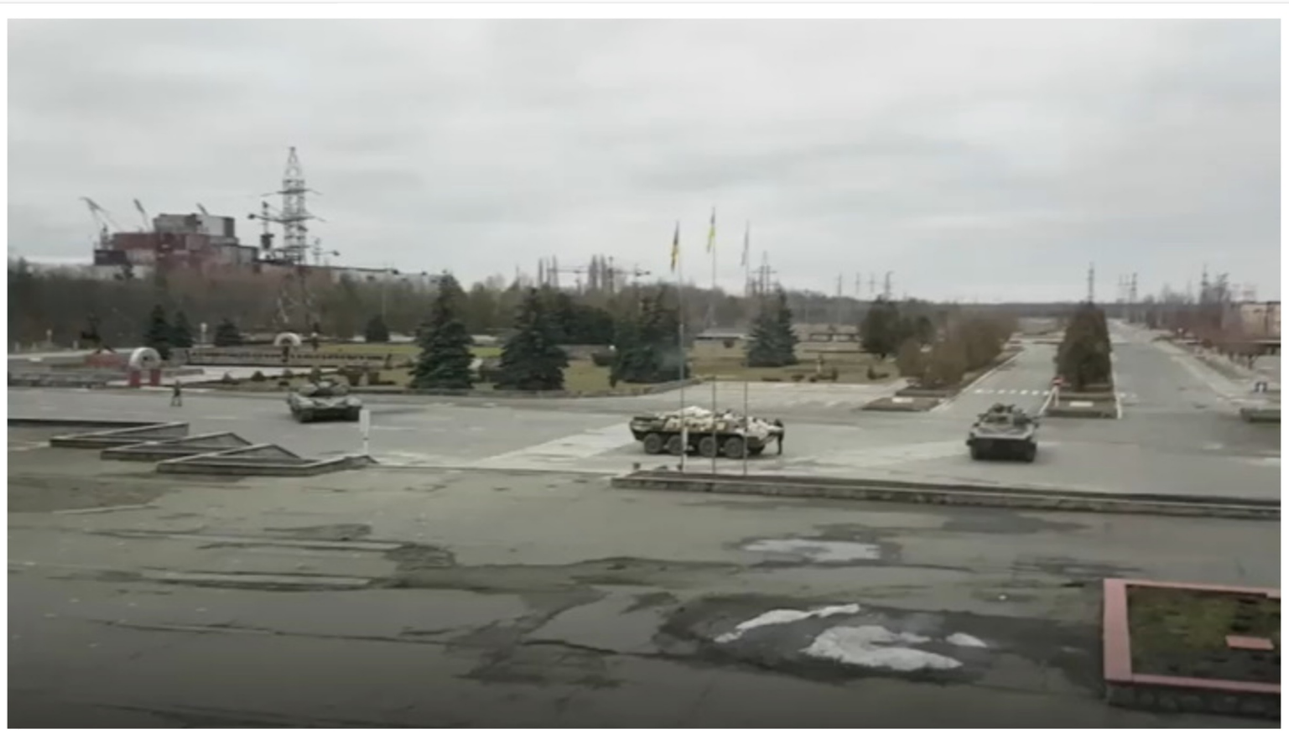
A sporadic but potentially very important way of contamination relocation are forest fires which have been discussed in detail earlier. They can mobilize about 4% of the total inventory per event as compared to about 1.7 % for natural resuspension immediately at the border between a contaminated and a clean zone.

In comparison with natural processes no anthropogenic activity, such as traffic, significatively contributes to redistributing radioactive materials. Essentially, **the resuspension of radioactive dust due to traffic is a local event** as a result of vehicle-induced turbulences over the surface, as well as the shear and friction forces from the tires (or wheels).

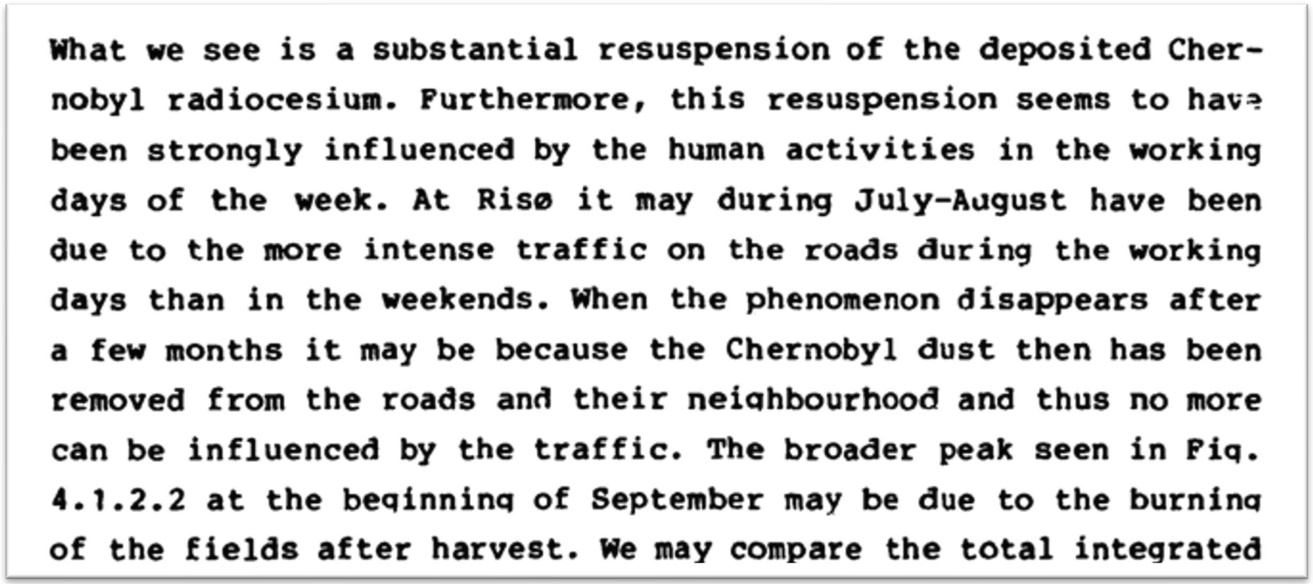
Humidity

- Resuspension was found to respond extremely sensitively to soil humidity: a 10% relative soil humidity reduced the resuspension factor by a factor of 300 in podzolic soil.

Resuspension factor (ratio of activity in the air to the surface deposit) **decreases exponentially** when the soil moisture increases.



Traffic



What we see is a substantial resuspension of the deposited Chernobyl radiocesium. Furthermore, this resuspension seems to have been strongly influenced by the human activities in the working days of the week. At Risø it may during July-August have been due to the more intense traffic on the roads during the working days than in the weekends. When the phenomenon disappears after a few months it may be because the Chernobyl dust then has been removed from the roads and their neighbourhood and thus no more can be influenced by the traffic. The broader peak seen in Fig. 4.1.2.2 at the beginning of September may be due to the burning of the fields after harvest. We may compare the total integrated

https://inis.iaea.org/collection/NCLCollectionStore/_Public/20/021/20021982.pdf

1. After a rapid period of resuspension due to the initial traffic activity, the remaining vehicles would not be contributing that much to the resuspension rate, because basically there are no materials left to be resuspended. This behavior is exactly what happened in Denmark in 1986, just a few months after the Chernobyl accident.
2. Roads in the CEZ have been decontaminated since 1989. In addition to this, we must bear in mind the large number of vehicles that have been circulating throughout the CEZ during the last 30 years.

The physical processes that had to take place in the CEZ to give any credence to the ‘resuspension of soil’ explanation are the exact opposite of what has been described in the scientific literature.

2. CYBER

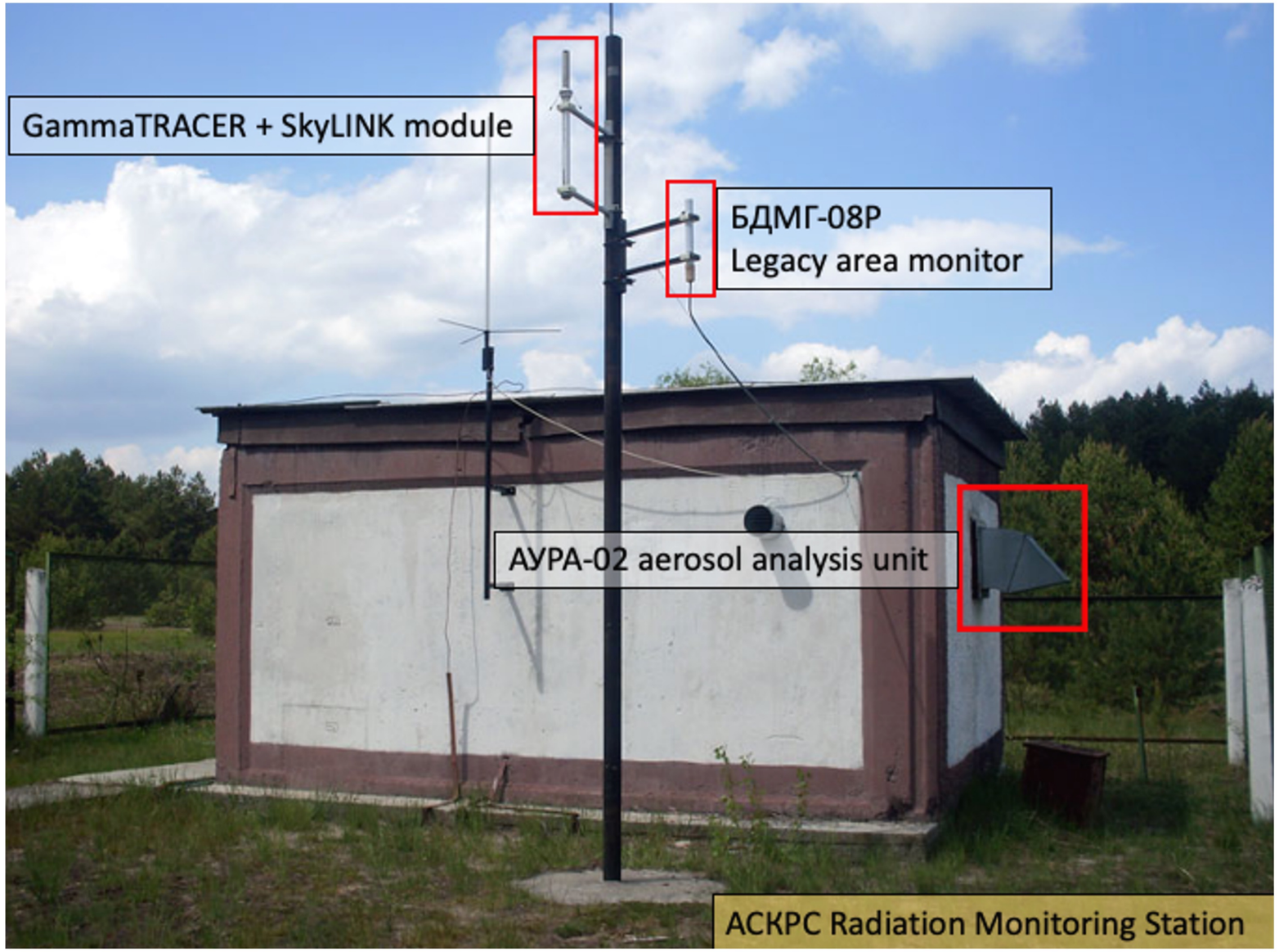
Chernobyl Exclusion Zone

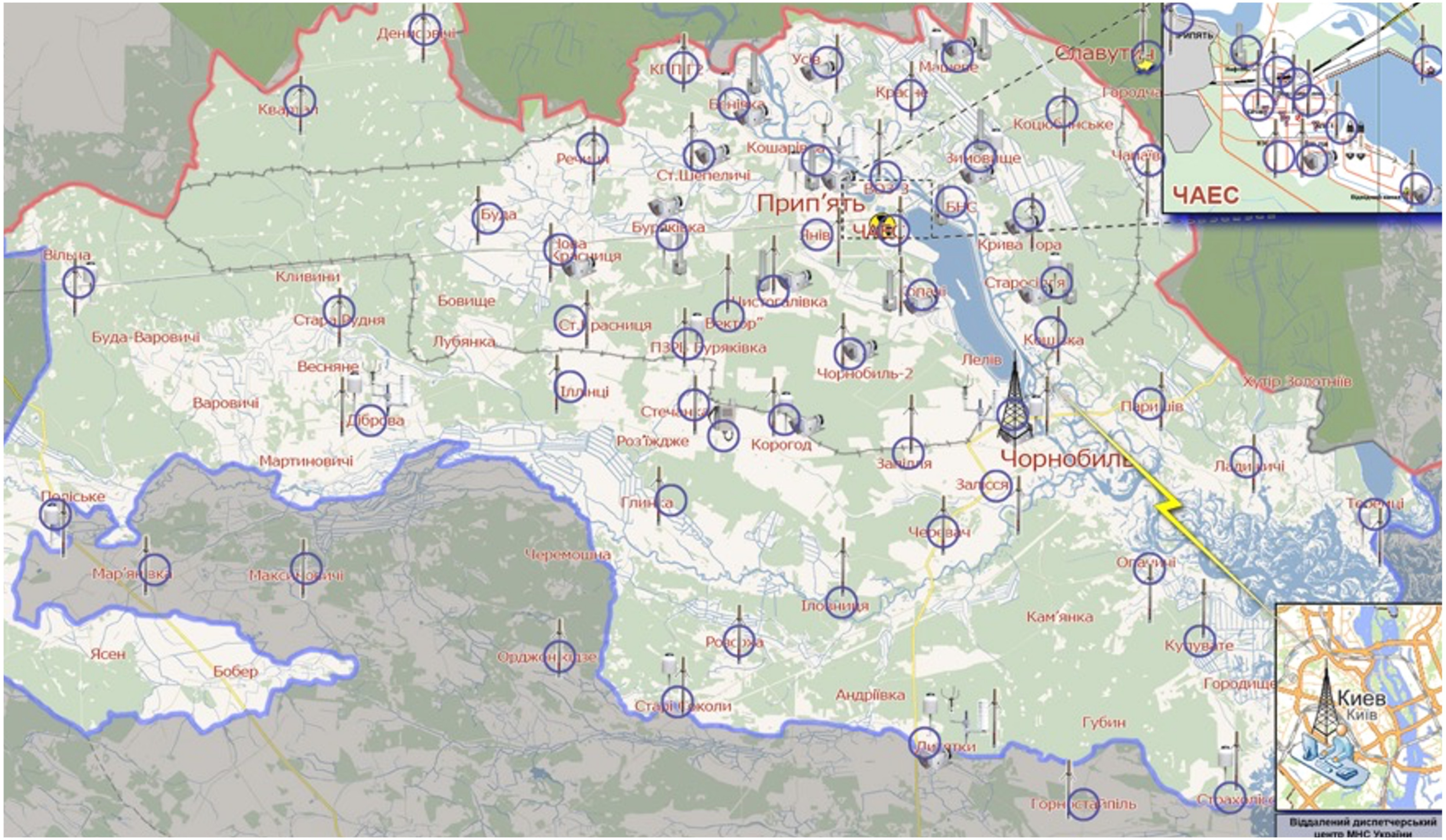
SAPHYMO

Tacis

SkyLINK®

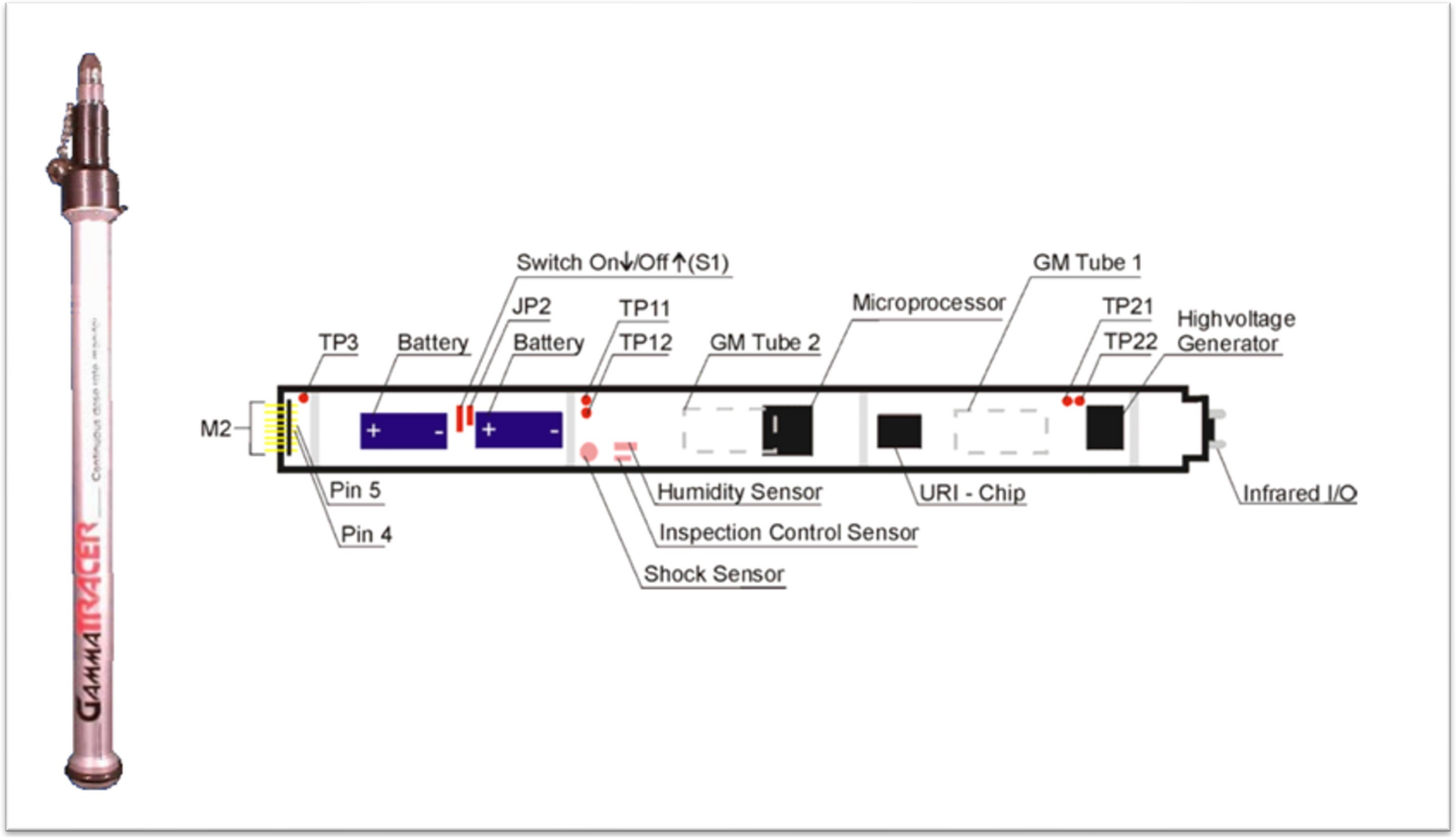
- SkyLINK system for data transmission
- ERMS measuring stations :
  - 71 Dose rate probes - GammaTRACER Wide Radio
  - 18 Aerosol samplers
  - 1 Aerosol monitor
  - 1 Weather station
- System for data transmission between measurement locations and data central


GammaTRACER + SkyLINK module
БДМГ-08Р
Legacy area monitor
АУРА-02 aerosol analysis unit
АСКРС Radiation Monitoring Station



Денисовичі
КПП Т2
Славутич
Прип'ять
ЧАЕС
Чорнобиль
Ст.Шепеличі
Речиця
Буда
Бовище
Кливини
Лубянка
Буда-Варовичі
Весняне
Варовичі
Мартиновичі
Черемошна
Ясен
Бобер
Андріївка
Губин
Кам'янка
Лелів
Хутір Золотніїв
Чорнобиль-2
Корогод
Буряківка
ПЗРО Буряківка
Вектор
Чистогалівка
Розїжджe
Глинка
Іллінці
Зимовище
Городище
Киев
Київ
Віддалений диспетчерський центр МНС України

The GammaTRACER is an autonomous gamma measurement probe. It is designed for continuously measuring, recording, and optionally transmitting the ambient equivalent dose rate (H*(10))



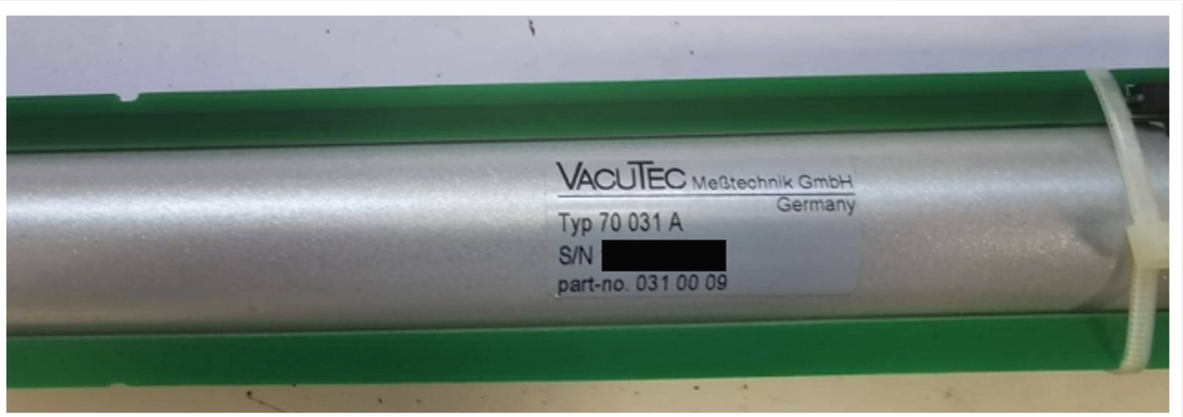
Autonomous

It contains 2 batteries that allow the device to operate autonomously for up to 10 years, depending on the configuration of measurement cycles, but usually run for 5 years.

Measuring

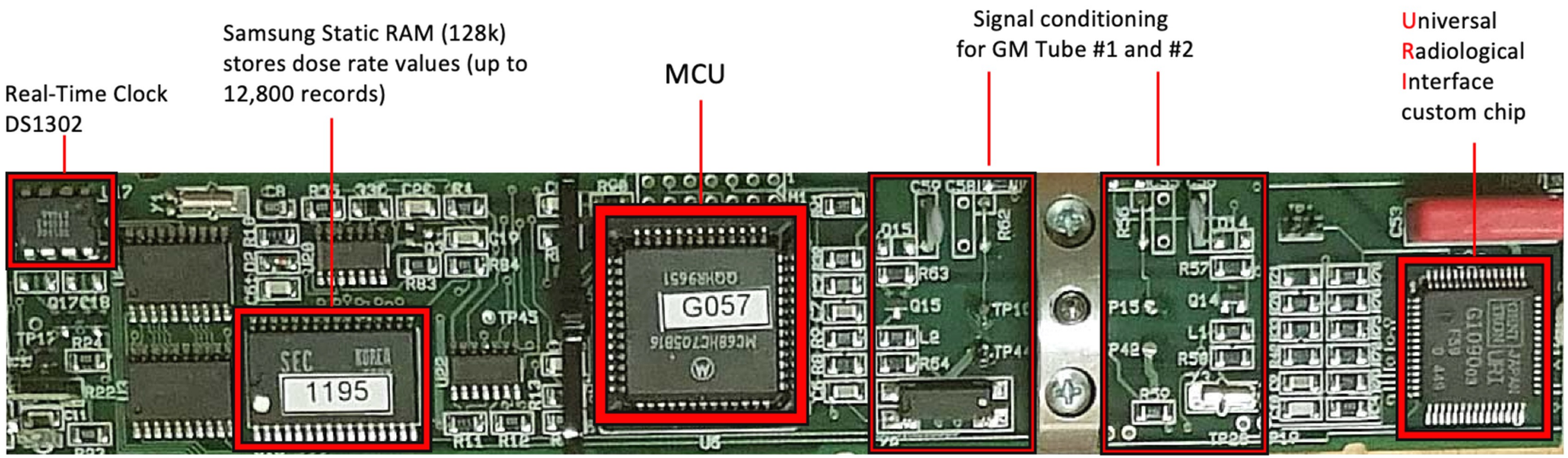
- Two energy-compensated VacuTec 70003A GM tubes
- Windowless
- High energy ionization events only (Gamma/X-Rays)

GammaTRACER Basic



GammaTRACER XL

Recording



GammaTRACER

- Normal: 60 minutes
- Emergency: 2 minutes (Control Level exceeded)
- **Timestamps generated by an internal, Real-Time clock**

ID	NAME	Control Level (nSv/h)
1	DGS-2	29000
2	VZS-2	21000
3	HZHTO	18400
4	Naftobaza	13500
5	HOYAT	9200
6	BNS	5000
7	Pozharne Depo	4800
8	VRP-750	4500
9	ABK-1	1400
10	Vidvodny kanal	1100
11	VOS-3	800
12	HOYAT-2	550
13	Chistogalivka	2300
14	Kopachi	1900
15	Yanov Station	1700
16	Pripyat	1500
17	Buryakovka	7500
18	Usiv	3600
19	Mashevo	2200
20	Zimovyshe	2100
21	Krasno	2000
22	Kryva Gora	1200
23	PZRO Buryakovka	1100
24	Chernobyl-2	840
25	Stari Shypelychi	740
26	Benevka	600
27	Starosillya	460
28	Vektor	270
29	Dibrova	700
30	Vilcha	470
31	Ilovnycya	380
32	Ilinci	260
33	Korogod	260
34	Parishev	250
35	Dityatki	220
36	Kupovate	220
37	Clinic	550
38	RUZOD	370
39	Slavutych	300

Transmitting

CHARACTERISTICS OF THE SYSTEM

• **Type of communication / - modulation:**	Unidirectional transmission of compact data blocks
• **Network structure:**	Typically 3 … 1 000 sensors to one or more central receivers possible
• **Data transmission rate:**	150 Bd
• **Error correction and verification of integrity:**	FEC and CRC error detection
• **Frequency stability over temperature range:**	Typically ± 2 ppm
• **Operating distance range:**	SkyLINK: Up to 100 km (60mi) line of sight (LOS) @ 10 mW ShortLINK: Up to 5 km (3 mi) line of sight (LOS) @ 10 mW
• **Standard frequency range:**	400 … 500 MHz
• **Operating temperature (transmitter):**	-20 … +50° C (-4 …+140° F) optional -40 … +60° C (-4 …+158° F) or -10 … +70° C (-104 …+158° F)
• **Receiver sensitivity:**	SkyLINK: -143 dB / ShortLINK: -125 dB

Data reception system

SkyLINK: transmission up to 100 km (ShortLINK: up to 5 km)

GammaTRACER radio probe

SkyLINK/ShortLINK system

Central data acquisition system

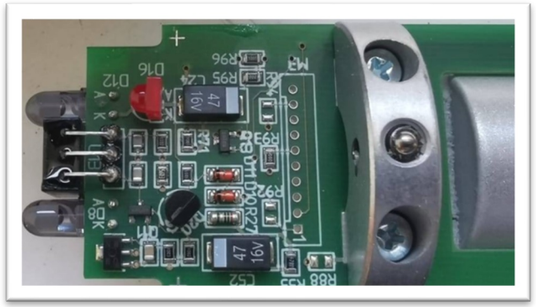
Data Management software DataEXPERT (option WebVIEW)

http://www.saphymo.de/ftp/ecatalogue/133/29297895EN_D_-_Data_Sheet_SHORT-SKYLINK.pdf

SkyLINK TX Module

Data Collection

GT Protocol over RS232/InfraRed



Forensics

- Dump internal storage (readings)
- DataGATE

```
bool flag = PQ == 'J';
checked
{
    bool result;
    try
    {
        this.GammaTracerPort.BaudRate = 9600;
        this.OpenPort();
        bool flag2 = !this.PTVers_FindPQV(this.lastITid, this.lastITVid, PQ).isValid();
        if (flag2)
        {
            TopMostMessageBox.Show(Program.Languages.GetLanguageString("Instrument firmware version doesn't include this command yet."));
            result = false;
        }
        else
        {
            ComApi_GT.DebugMessLD("********** Request data");
            int num;
            bool flag3 = (num = this.SendCommandGT(PQ, this.PTVers_FindPQV(this.lastITid, this.lastITVid, PQ).PQV, MIidS, comB, true)) !=
```

Anti-forensics

- Reset internal storage
- Update Firmware (wipe memory)

```
xt:100016B1                 call    sub_100023A0
xt:100016B6                 call    sub_10002690
xt:100016BB                 push    offset aProgramMemoryO ; "\n\n\n Program memory OK\n"
xt:100016C0                 call    sub_100010A0
xt:100016C5                 add     esp, 4
xt:100016C8                 call    sub_10002C7C
xt:100016CD                 pop     edi
xt:100016CE                 xor     eax, eax
xt:100016D0                 pop     esi
xt:100016D1                 add     esp, 0Ch
xt:100016D4                 retn
xt:100016D5 ; ---------------------------------------------------------------------------
xt:100016D5
xt:100016D5 loc_100016D5:                           ; CODE XREF: GTUpdateFirmware+3B2↑j
xt:100016D5                 push    eax
xt:100016D6                 push    offset aThisVersion0x0 ; "This version [0x%02X] of protocol not {"...
xt:100016DB                 push    offset unk_1000EC38
xt:100016E0                 call    sub_10001150
xt:100016E5                 add     esp, 0Ch
xt:100016E8                 call    sub_10002690
xt:100016ED                 pop     edi
xt:100016EE                 mov     eax, 9
xt:100016F3                 pop     esi
xt:100016F4                 add     esp, 0Ch
xt:100016F7                 retn
xt:100016F8 ; ---------------------------------------------------------------------------
xt:100016F8
xt:100016F8 loc_100016F8:                           ; CODE XREF: GTUpdateFirmware+1A6↑j
xt:100016F8                 push    offset aCanTReadMcuInf ; "Can't read MCU info. Could be protocol "...
xt:100016FD                 push    offset unk_1000EC38
xt:10001702                 call    sub_10001150
xt:10001707                 push    offset aOrForgotToSetS ; "(Or forgot to set single wire mode?)\n"
xt:1000170C                 push    offset unk_1000EC38
xt:10001711                 call    sub_10001150
xt:10001716                 add     esp, 10h
xt:10001719                 call    sub_10002690
xt:1000171E                 pop     edi
xt:1000171F                 mov     eax, 5
```

> “As far as environmental monitoring is concerned, many of the fixed and mobile monitoring stations were damaged and were out of service”.(IAEA, 2022)

Central Processing Station

1. UPS unit
2. Downconverter
3. DSP modules
4. Computer

1. Bertin Instruments' DataEXPERT Software (left) showing the 39 regulatory stations (green bars).
2. Ecocentre's Custom Software (right) apparently implementing radiation forecast, dispersion models, etc (Real-Time Online Decision Support System)
3. Workstations
4. Primary Data Center

3. Timeline of Relevant Events

February 4

Ukraine holds military drills within the CEZ, in the abandoned town of Pripyat. Nearby radiation monitoring stations did not detect abnormal radiation levels.

Mick Krever/CNN

Journalists film Ukrainian live fire exercises in the abandoned town of Pripyat, in the Chernobyl Exclusion Zone, on February 4

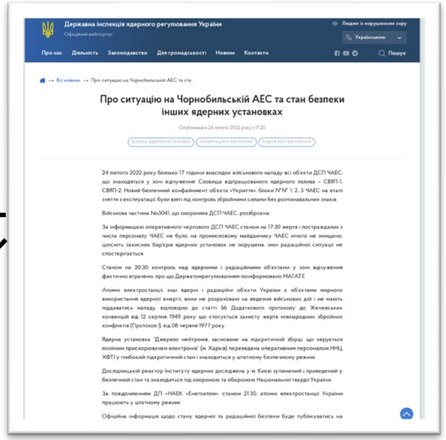
February 24 – 16:00

A portion of the Russian military units then headed to Vyshhorod, 90 km south of Chernobyl. A video recorded at Checkpoint Leliv seems to capture that moment. Please also note that they are passing through a VM250 radiation portal monitor

February 24 – SNRIU STATEMENT

According to the information of the operative duty dispatcher of the ChNPP as of 5:30 p.m., there were no casualties or injuries among the personnel of the ChNPP, nothing was destroyed on the industrial site of the ChNPP, the integrity of the protective barriers of nuclear installations was not violated, and no changes in the radiation situation were observed.

За інформацією оперативного диспетчера ЧАЕС станом на 17:30, втрат та травм серед персоналу ЧАЕС немає, на проммайданчику ЧАЕС нічого не зруйновано, цілісність захисних огороджень ЧАЕС. ядерних установок порушень не було, змін радіаційної обстановки не спостерігалося.



As of 8:30 p.m., control over nuclear and radiation facilities in the exclusion zone was effectively lost, as the State Nuclear Regulatory Commission informed the IAEA.

Станом на 20:30 контроль за ядерними та радіаційними об'єктами в зоні відчуження фактично втрачено, про що Держатомрегулювання повідомило МАГАТЕ.

https: //snriu.gov.ua/news/pro-situaciyu-na-chornobilskij-aes-ta-stan-bezpeki-inshih-yadernih-ustanovkah

Feb 25 – 8:15

Feb 25 – 9:00

The SNRUI publishes a statement introducing the ‘resuspension of soil’ explanation,

> Experts of the Ecocenter connect this with disturbance of the top layer of soil from movement of a large number of radio heavy military machinery through the Exclusion zone and increase of air pollution.(SNRUI, 2022)

https://snriu.gov.ua/en/news/updated-information-radiation-situation-exclusive-zone

March 31
Russian occupation forces withdraw from the CEZ.

April 14
In a press conference, Yeygen Kramarenko, head of the agency for the Chernobyl Exclusion Zone, confirms that the **server** in charge of processing data from the radiation monitoring stations '**has disappeared**'.

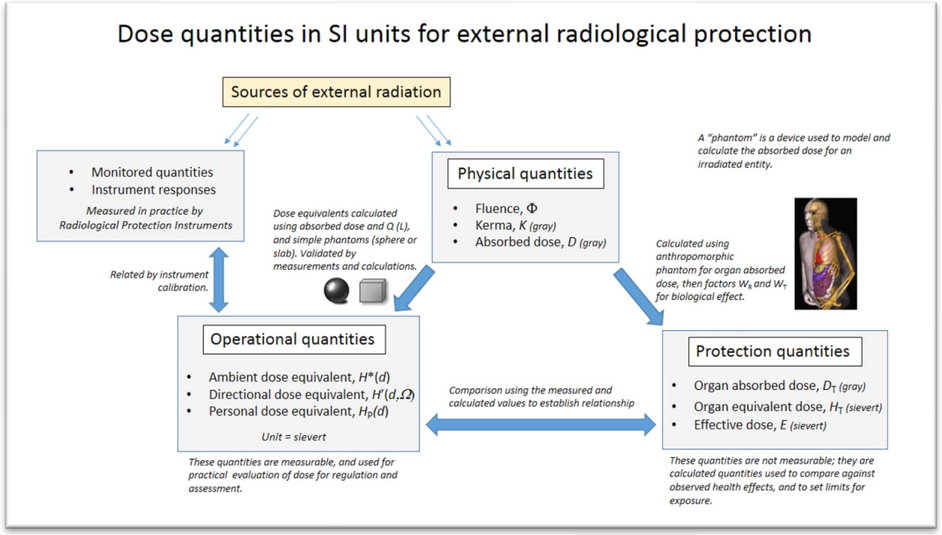
June 7
According to the IAEA the radiation monitoring network in the CEZ has been restored.
The statement starts with the following sentence:
'Dozens of radiation detectors are once again transmitting data from the area around the Chornobyl Nuclear Power Plant (NPP) .'

4. Technical Analysis

Crucial Detail

From a dosimetry perspective, '**increased radiation levels**' is subject to many interpretations.

The GammaTRACERs are area monitors intended to determine the **ambient equivalent dose rate**(H*(10)), an **operational quantity** for **area monitoring**.



"If there had been a very intense movement of vehicles, especially with chains, in the most contaminated area, a few kilometers around the plant, it is possible that slight increases in the concentration of radioactive aerosols would have been observed in the air, as a consequence of the resuspension of radioactive materials deposited in the ground, which after 35 years have penetrated into subsoil layers. However, I doubt that they will have an impact on the level of direct radiation indicated by the graphs submitted". (Gil, 2022)

https://maldita.es/malditobulo/20220225/aumento-radiacion-chernobil-militares-rusos/

Державного агентства України
з управління зоною
відчуження
Євгену КРАМАРЕНКУ

Довідка
про перевищення показників ПЕД на постах контролю АСКРС

У таблиці 1 наведені характеристики потужності еквівалентної дози гамма-випромінювання (ПЕД), що реєструвалися на постах моніторингу АСКРС протягом доби 24.02.2022 року у порівнянні з середньорічними значеннями за 2021 рік та контрольними рівнями (КР).

№ п/п	Назва пункту	Зафіксоване значення	Середнє значення за 2021 рік	Контрольний рівень	Перевищення Контрольного рівня
1	Пожежне депо	9460	1900	4800	2,0
2	Станція Янів	3460	670	1700	2,0
3	Машево	8040	840	2200	3,6
4	Красне	3340	720	2000	1,7
5	Зимовище	8220	780	2100	3,9
6	Вектор	2050	130	270	7,6

"The EDR of gamma radiation in the CEZ is now almost entirely formed by the gamma radiation of Cs137, which arises as a result of its radioactive decay. The main source of radiation is the top layer of soil, where the reserves of this radionuclide are in dynamic equilibrium due to its inclusion in the circulation of substances "soil - plant - soil".

в кругообіг речовини «грунт – рослина - грунт.

Тому зафіксоване перевищення контрольних рівнів за нашими оцінками

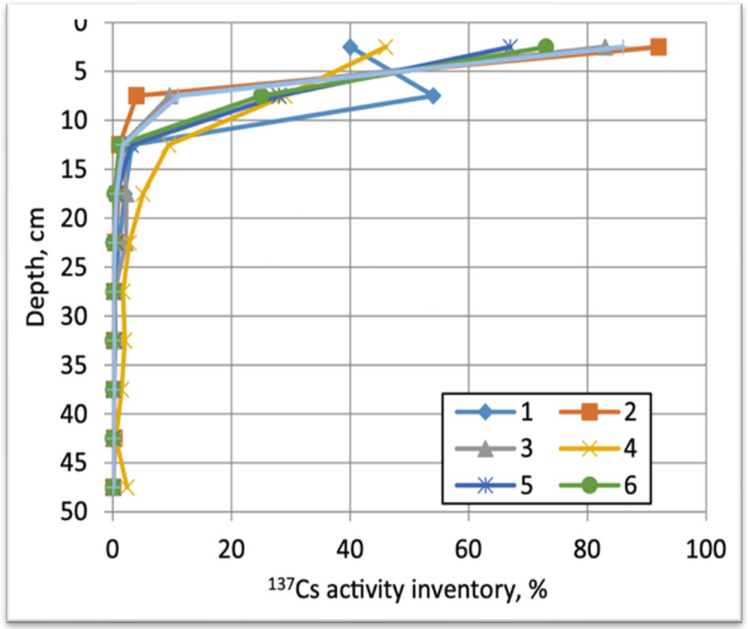
Therefore, according to our estimates, the recorded excess of the control levels is related to the violation of the upper layer of the earth, which is caused by the movement of important equipment and the lifting of radioactive dust into the air."

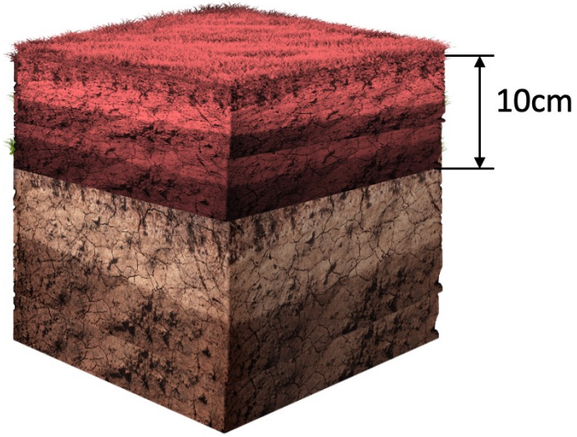
Генеральний директор ДСП «Екоцентр» Сергій КІРЄЄВ

The 'equilibrium' of the radioactivity in the surface layer of the ground was then upset by the traffic of heavy military vehicles, which stirred up radioactive dust, thus causing the radiation spikes.

The imbalance of the equilibrium

The vertical distribution of ^{137}Cs in the forested (and/or unpaved) parts of the CEZ follows an exponential profile where approximately 90% of the activity is in the top layer of soil (0-10 cm)





1. The shielding effect of the upper layer of soil is negligible because the main contributor of the detected H*(10) throughout the CEZ, is this very upper layer.
2. Even if we disturb the surface by driving heavy vehicles over it, this activity will not let any significant amount of gamma radiation ‘escape’ from the deeper layers.
3. Gamma radiation interacts with matter according to the Beer-Lambert attenuation law. It is simply unrealistic to think that the mass attenuation coefficient of the soil in the CEZ in addition to just several centimeters of (already) contaminated ground, can provide any significant attenuation to a ‘deeper’ layer of gamma activity, which in fact, does not even exist.

- $T_{grd \rightarrow air}(\tau_0) = 10^{-3}$ m^{-1} is the transfer factor from the ground to the air (by wind or other natural processes), at time τ_0. The default value was based on an examination of the results of Eq. (8) shown in Table 18 for different conditions. The default value was selected, because it would be conservative compared with most of those normally encountered by the public while living normally in an area. However, the inhalation and cloud shine doses from resuspended material are not significant contributors following a severe release of radioactive material from an LWR or its spent fuel.

$$T_{grd \rightarrow air}(\tau_0) \equiv \frac{\text{Concentration in the air}}{\text{Concentration on the ground}} \quad \frac{[Bq/m^3]}{[Bq/m^2]} \qquad (8)$$

IAEA - 2017

Operational
Intervention Levels
for Reactor Emergencies
and Methodology for Their Derivation

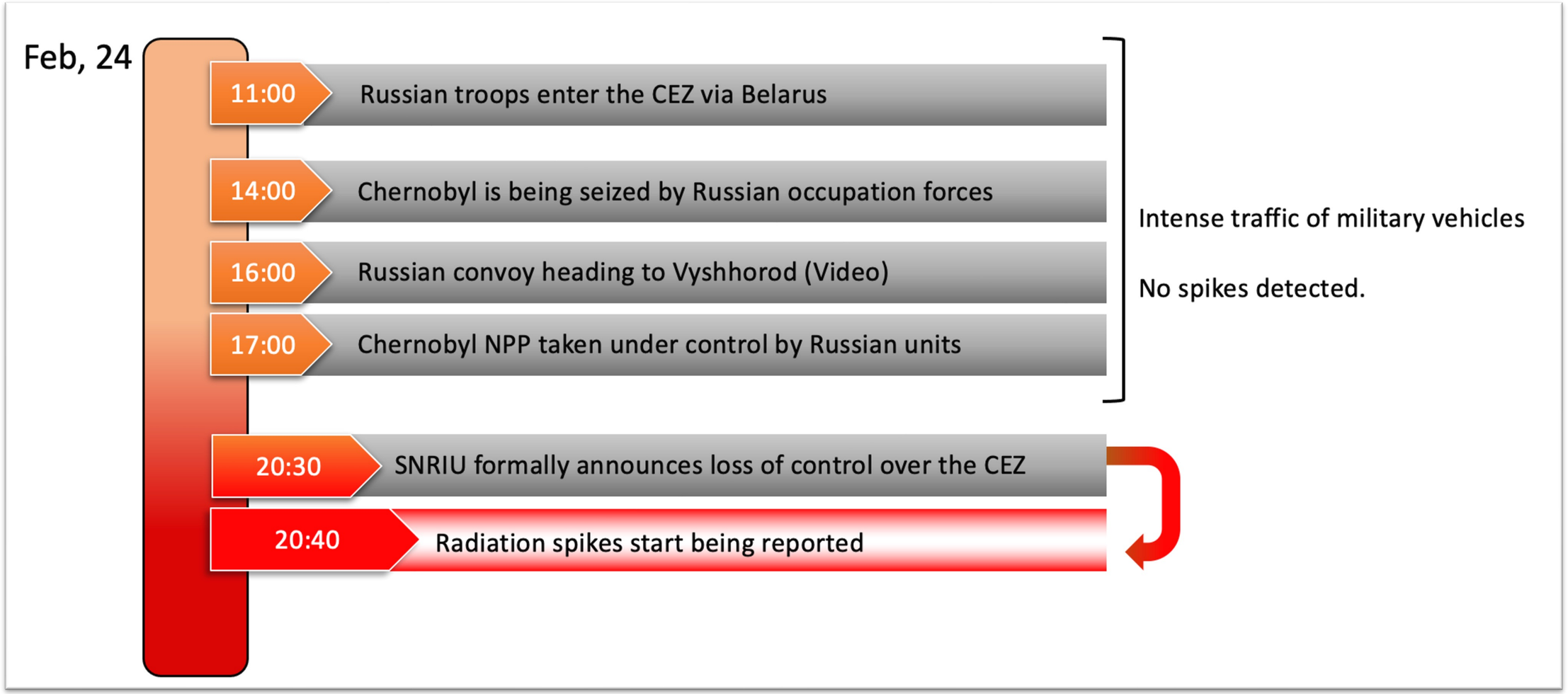
https://www-pub.iaea.org/MTCD/Publications/PDF/EPR_NPP_OILs_2017_web.pdf

It should be noted that this dose is much lower than that which results from the external exposure of fire-fighters by the radiation emitted by the contaminated soil and which, in the exclusion zone, is very often greater than 1 µSv/h. This is consistent with estimates made by Ukrainian scientists which indicate that the doses received by fire-fighters as a result of smoke inhalation are in the range of 1% of the dose induced from the exposure to ground radiation[8].

IRSN - 2020

https://www.irsn.fr/EN/newsroom/News/Documents/IRSN_Information-Report_Fires-in-Ukraine-in-the-Exclusion-Zone-around-chernobyl-NPP_15042020.pdf

Unphysical timings



February 24

A Russian convoy of +100 military vehicles passed through Checkpoint Leliv around 16:00, south bound, using the main road between ChNPP and Chernobyl

However, the radiation monitoring station at Kopachi, which is located along the way of this convoy, didn't report a spike until the morning of the 25th

Pryp'yat'
Прип'ять

Red Forest
Рудий ліс

Chernobyl Nuclear Power Plant
Чорнобильська атомна електростанція

Pripyat River

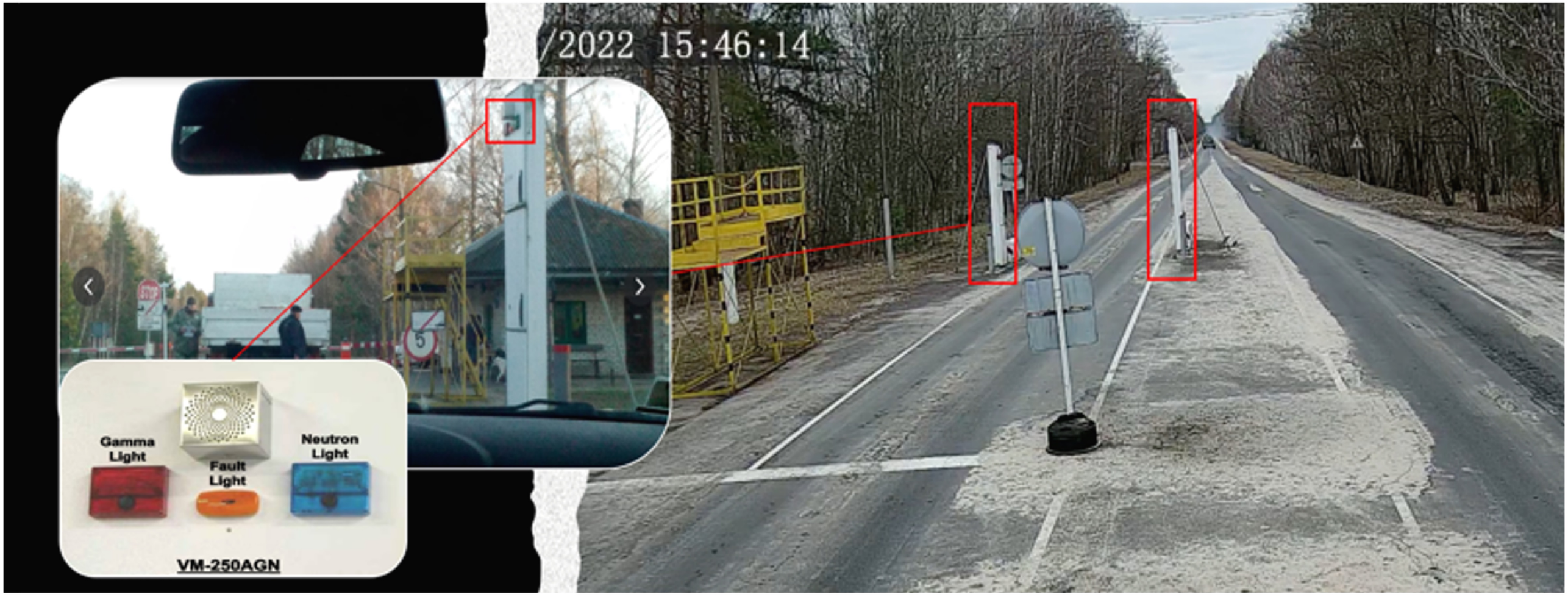
Kryva Hora
Крива Гора

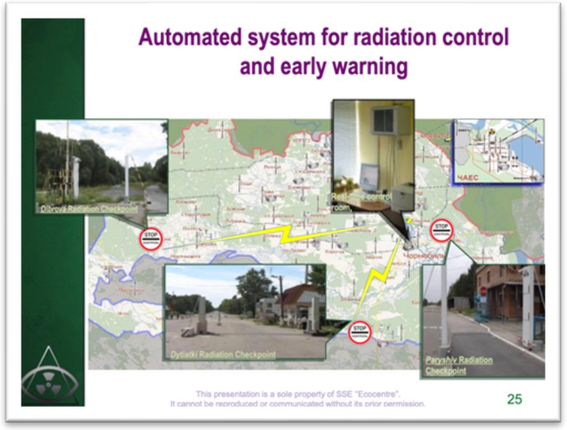
Kopachi

Monument to the heroes of World War II
Пам'ятник героям Другої Світової Війни

Pripyat River

Checkpoint Leliv





1. The cameras that recorded the video are part of another radiation monitoring system, different from the ASKRS, installed at the CEZ checkpoints for the purpose of non-proliferation control.
2. The two white pillars located on the left lane are part of a VM250 Radiation Portal Monitor.
3. The VM250 can switch over to battery power when AC is lost.
4. Recorded values were sent to a central processing station.
5. There is no information about whether the server containing these records was recovered or examined.

The Perfect Storm of 2020

The scientific literature agrees on the fact that, among the anthropogenic and natural activities that may lead to resuspension of radioactive materials, forest fires have the biggest impact. The extent of this influence covers both transport (and redistribution due to a subsequent deposition) and contribution to the increment of the activity of radionuclides in air

In April 2020, the Chernobyl Exclusion Zone suffered a ‘perfect storm’ of forest fires, the largest ever recorded in the zone. Resuspended ^{137}Cs reached Kiev.

IRSN - 2020

Ambient gamma dose rate measurements near fire-affected areas are available at http://www.srp.ecocentre.kiev.ua/MEDO-PS/index.php?lang=ENG. They do not reveal abnormal values. It should be remembered that these measurement devices are only capable of detecting major radiological accidents[1]. Such a probe is installed at the French Embassy in Kiev and is part of the IRSN's Téléray network deployed in France. 1

The radioactivity released into the atmosphere by the fires was therefore not high enough to be detected by these devices. 2

On the other hand, much more sensitive measurements have been carried out by various Ukrainian scientific bodies which have published airborne ^{137}Cs activities from aerosol samplings[2] (see Table 1). 3

---

[1] Gamma radiation resulting from radioactivity in air greater than 1 Bq/m^3 4

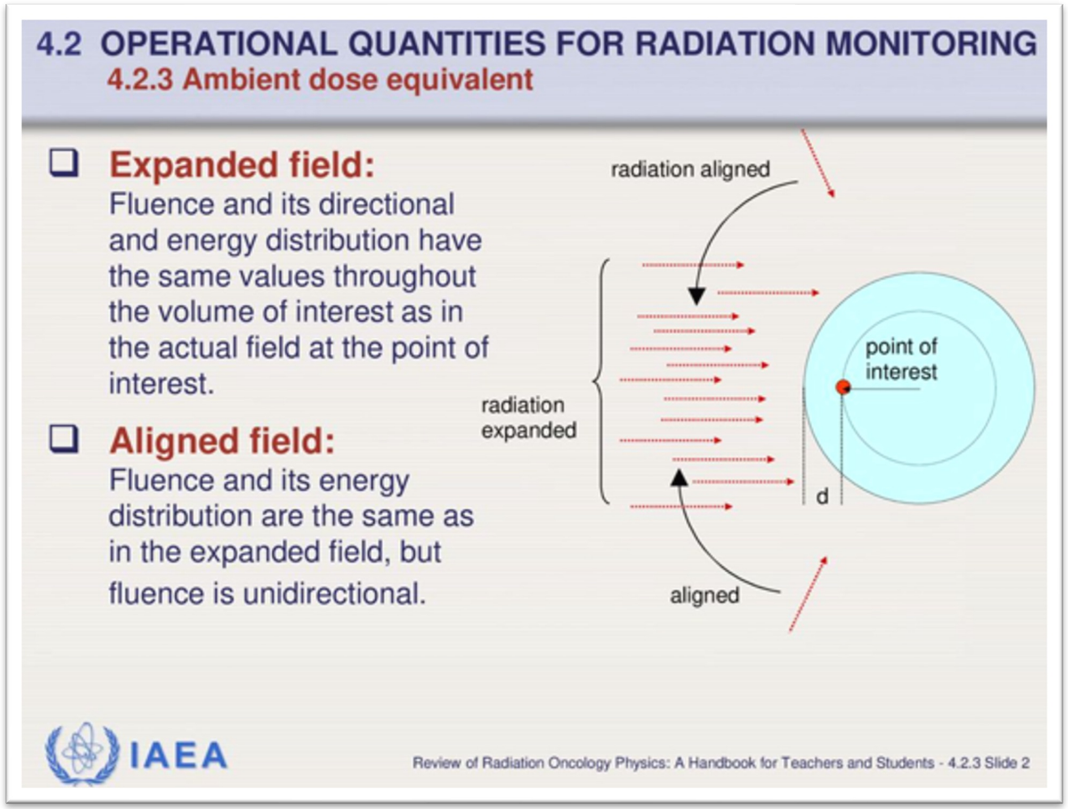
[2] Airborne particulate matter

- The biggest forest fires ever recorded in the CEZ did not resuspend enough ^{137}Cs to provoke an increase of the H*(10) calculated by the GammaTRACER probes.

- Heavy military vehicles driving over decontaminated roads in the CEZ, resuspended enough ^{137}Cs to increase the H*(10) to levels that even exceeded those detected right after the accident at the Fukushima Daiichi NPP.

A simple mathematical model to understand the unphysical radiation spikes

This additive property allows us to come up with the following approach, where we decompose the expanded and aligned radiation field into different components.



(144) In the proposed definitions, the ambient dose, H^*, at a point in a radiation field, is defined as the product of the particle fluence, Φ, at that point and a conversion coefficient, $h^*_{E_{max}}$, relating the particle fluence to the maximum value of effective dose, E_{max}. The conversion coefficients are calculated for exposures of the whole body of the ICRP adult reference phantoms (ICRP, 2009) for broad idealised parallel beams of the radiation field incident in irradiation geometries along the antero-posterior, postero-anterior, left lateral, and right latera axes, for 360° rotational directions, fully isotropic irradiation, superior hemisphere semi-isotropic irradiation, and inferior hemisphere semi-isotropic irradiation fields.

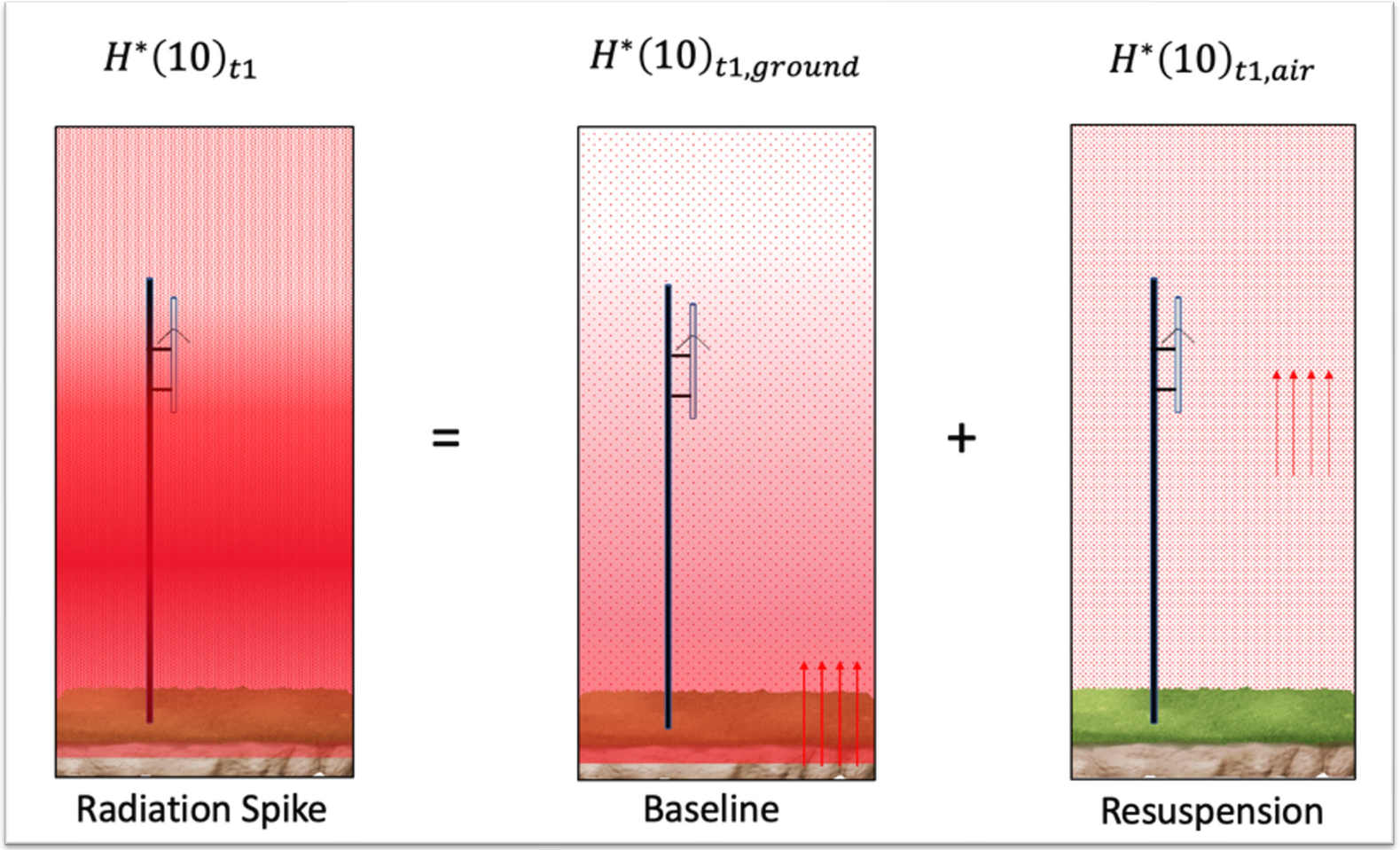
(145) The ambient dose coefficients are given by $h^*_{E_{max,i}}(E_p) = E_{max,i}(E_p)/\Phi(E_p)$, where the fluence values are those for particle type, *i*, at the point of interest, with kinetic energy, E_p. For particles of type *i*:

$$H_i^* = \int h^*_{E_{max,i}}(E_p)\frac{d\Phi_i(E_p)}{dE_p}dE_p \quad (6.1)$$

where $d\Phi_i(E_p)/dE_p$ is the fluence of particles at that point with kinetic energies in the interval dE_p around E_p. The sum over all contributing particle types, *i*, is the quantity H^*:

$$H^* = \sum H_i^* \quad (6.2)$$

‘Estimating the terrestrial gamma dose rate by decomposition of the ambient dose equivalent rate.’
https://publications.jrc.ec.europa.eu/repository/handle/JRC98453



Please note that we are not trying to either harmonize or estimate the H*(10) between different radiation monitoring devices. This approach is possible because we have a dataset that contains years of measurements collected from the same monitoring devices. Thus, despite the different periodicities, after so many years the baseline level for each of these stations is stable enough to be used as a reference.

1. $H^*(10)_{t0} = H^*(10)_{t0,ground} + H^*(10)_{t0,air}$

Arbitrary radiation monitoring station at time t_0

2. $H^*(10)_{t1} = H^*(10)_{t1,ground} + H^*(10)_{t1,air}$

Same radiation monitoring station detecting a spike at time t_1

3. $H^*(10)_{t1} \gg H^*(10)_{t0}$

The question is, which component would be enabling this significant increment?

4. $H^*(10)_{t1,air} \gg H^*(10)_{t0,air}$

As the official explanation states that these radiation spikes are linked to resuspended radioactive materials, it must be 'air'.

5. $A_{2020} = [H^*,(10)_{1,air}, , H^*(10)_{2,air} \dots H^*(10)_{n,air}]$

A_{2020} would be the set of the ambient equivalent dose rate values for the 'air' component, recorded during the 2020 forest fires for an arbitrary station.

6. $H^*(10)_{t1,air} \gg \max(A_{2020})$

It was reported that the additional airborne ^{137}Cs activity due to resuspension of radioactive materials during the 2020 forest fires did not result in an increase of the total ambient dose equivalent in any station.

7. $\alpha = [a_1, , a_2, \dots a_n]$

As A_{2020} is not available, we can rewrite the previous expression based on a response function (f_r) representing the GammaTRACER response for the recorded airborne ^{137}Cs activities (Bq/m^3). This dataset (α) is available in 14 of the 39 regulatory stations, those that were equipped with the aerosol analysis units.

8. $f_r(a_{t1}) \gg f_r(\max(\alpha))$

$$H^*(10; f_r(a_{t1}))_{t1,air} \gg H^*(10; f_r(\max(\alpha))_{t0,air}$$

Expression that we should be able to validate

Example calculation: ’Buryakovka’

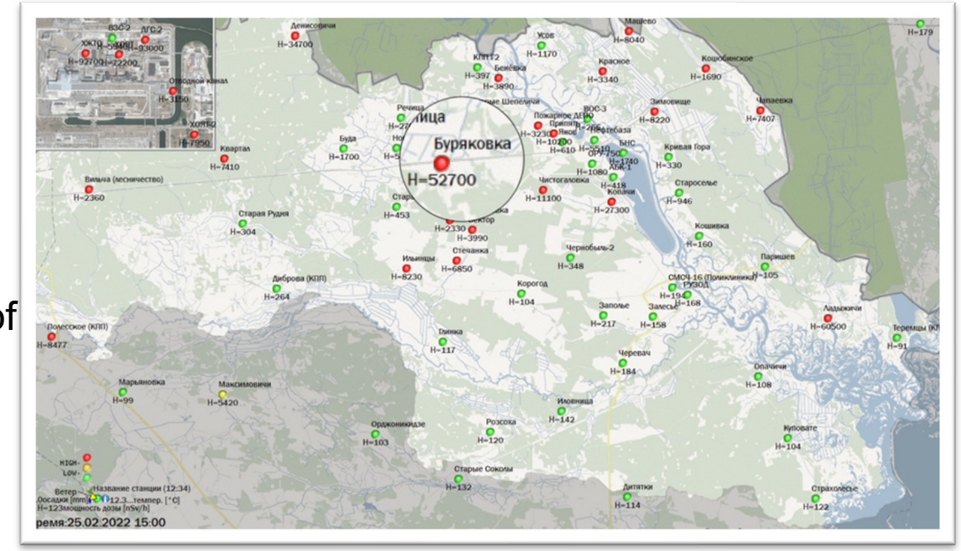
$$H^*(10)_{air} = H^*(10) - H^*(10)_{ground}$$

The radiation spike at Buryakovka reached 52700 nSv/h on the 25th of February.

The historic data collected from different documents shows an average value of around 2700 nSv/h.

$$H^*(10)_{air} = 52700 - 2700$$

$$H^*(10)_{air} = 50000\ nSvh^{-1}$$



According to this, the resuspension process itself should generate enough airborne ^{137}Cs activity to allow the GammaTRACER to detect 50 μSv/h.

For reference purposes, in 1986, just few weeks after the accident, an estimated dose rate of 50 μSv/h in air was the level used by the authorities to determine the evacuation zones in the 60km area around Chernobyl NPP.

Although, even at this point, 50 μSv/h is an unrealistic increment for a traffic-induced resuspension activity, let’s continue to illustrate the idea behind the model

Method to realistically approximate the airborne ^{137}Cs activity (a_{t1}) in 2022.

Table 2. Assumptions for the two potential exposure scenarios.

	Scenario A	Scenario B
Time spent on the site [hours] (note: construction worker always outdoors)	35 days × 24 hours per day = 840 hours	14 days × 24 hours per day = 336 hours
Time spent over disturbed ground (due to manual or mechanical digging) [hours]	Not considered in this Scenario	14 days × 12 hours per day = 168 hours
Time spent for manual digging [hours]	Not considered in this Scenario	16.8
Time spent for mechanical digging [hours]	Not considered in this Scenario	151.2
Time spent with contaminated material on the skin [hours]	420 (50% of time spent on the site)	168 (50% of time spent on the site)
Inhalation rate [m³/hour] normal activity	1.18	1.18
Inhalation rate during manual digging [m³/hour]	Not considered in this Scenario	1.69
Concentration of dust in air [g/m³] normal activity	5E-04	5E-04
Concentration of dust in air during digging [g/m3]	Not considered in this Scenario	5E-03
Fraction of area considered contaminated	1.0	1.0

Table 3. Radionuclides and their specific activity used in calculations.

NUCLIDE	SPECIFIC ACTIVITY (Bq/g)
Cs-137	5.90E+00

https://www.iaea.org/sites/default/files/22/09/ukraine-2ndsummaryreport_sept2022.pdf

The IAEA, responding to the claims that Russian troops dug trenches in the vicinity of the Red Forest, calculated the estimated effective dose potentially received by those soldiers.

Therefore, to approximate a_{t1} I used the values resulting from the measurements the IAEA performed on-site, which are publicly available

*Specific Activity * Concentration of dust in air during digging*

$$a_{t1} = 5{,}9 \times 5 \times 10^{-3}$$

$$a_{t1} = 2{,}95 \times 10^{-2}\ Bq/m^3$$

According to the 'Volumetric activity of ^{137}Cs in 2020' table, we have

$$\max(\alpha) = 1{,}1 \times 10^{-3}$$

By substituting the values in the expression, we have that a_{t1} is just an order of magnitude higher than the maximum airborne ^{137}Cs activity detected in Buryakovka in 2020.

$$H^*(10; f_r(2{,}95 \times 10^{-2}))_{t1,air} \gg H^*(10; f_r(1{,}1 \times 10^{-3})_{t0,air}$$

Assuming the radiation spikes were physically sound, we would have that an airborne ^{137}Cs activity of $2{,}95x10^{-2}$ Bq/m^3 led to the expected increase of the H*(10) until reaching 50 μSvh^{-1} over its baseline level ('ground' component).

Obviously, that is not the case. This activity does not even reach the reference airborne ^{137}Cs activity of 1 Bq/m^3 by two orders of magnitude. Also, if it were true, we should be observing 50 μSv/h increases (on top of their baseline levels) in all those stations that recorded similar increments in their airborne ^{137}Cs activities.

Volumetric activity of ^{137}Cs in 2020.

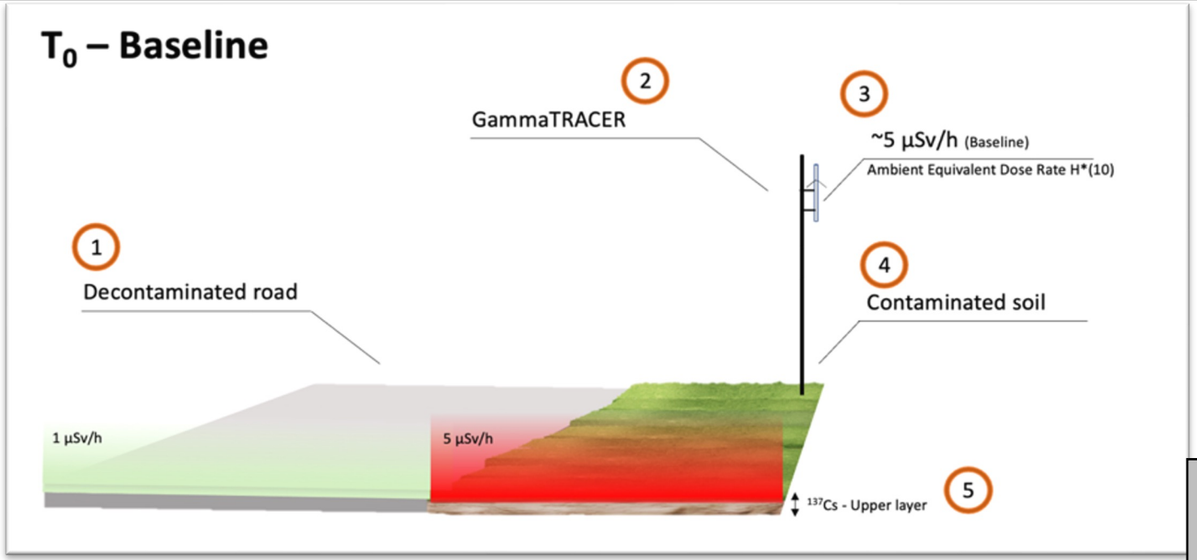
Пункт контролю	Віддаленість, азимут	Об'ємна активність		
		Minimal Мінімальна	Average Середня	Maximum Максимальна
Ближня зона				
ВРП-750	0,8 км; 180°	2,2E-05	4,6E-04	1,0E-02
Нафтобаза	2 км; 330°	8,9E-06	5,5E-04	1,0E-02
Прип'ять	3,1 км; 290°	4,8E-06	2,0E-04	7,6E-03
БНС	2,6 км; 85°	7,3E-06	2,2E-04	4,9E-03
Дальня зона				
Машеве	11 км; 19°	3,6E-06	7,3E-05	5,9E-04
Зимовище	7 км; 60°	1,9E-06	3,6E-05	3,3E-04
Старосілля	9 км; 119°	1,3E-06	2,9E-05	3,4E-04
Копачі	5 км; 155°	1,9E-06	1,4E-04	3,6E-03
Чорнобиль	16 км; 147°	3,5E-06	3,9E-05	4,0E-04
Дитятки	32 км; 175°	7,1E-07	1,2E-05	2,0E-04
Чистогалівка	7 км; 240°	3,8E-06	1,2E-04	9,0E-04
Бенівка	10 км; 306°	1,9E-06	6,5E-05	2,4E-03
Буряківка	13 км; 268°	2,0E-06	1,5E-04	1,1E-03
ПЗРВ	12,5 км; 250°	7,0E-06	8,2E-05	9,4E-04

Примітка: В таблиці запис вигляду 1,0E-02 означає $1{\times}10^{-2}$. *Bq/m³*

Let's take the highest airborne ^{137}Cs activity detected (1,0E-02) during the forest fires of 2020, which corresponds to the VRP-750 radiation monitoring station. This value is in the same order of magnitude as that our previously calculated a_{t1}

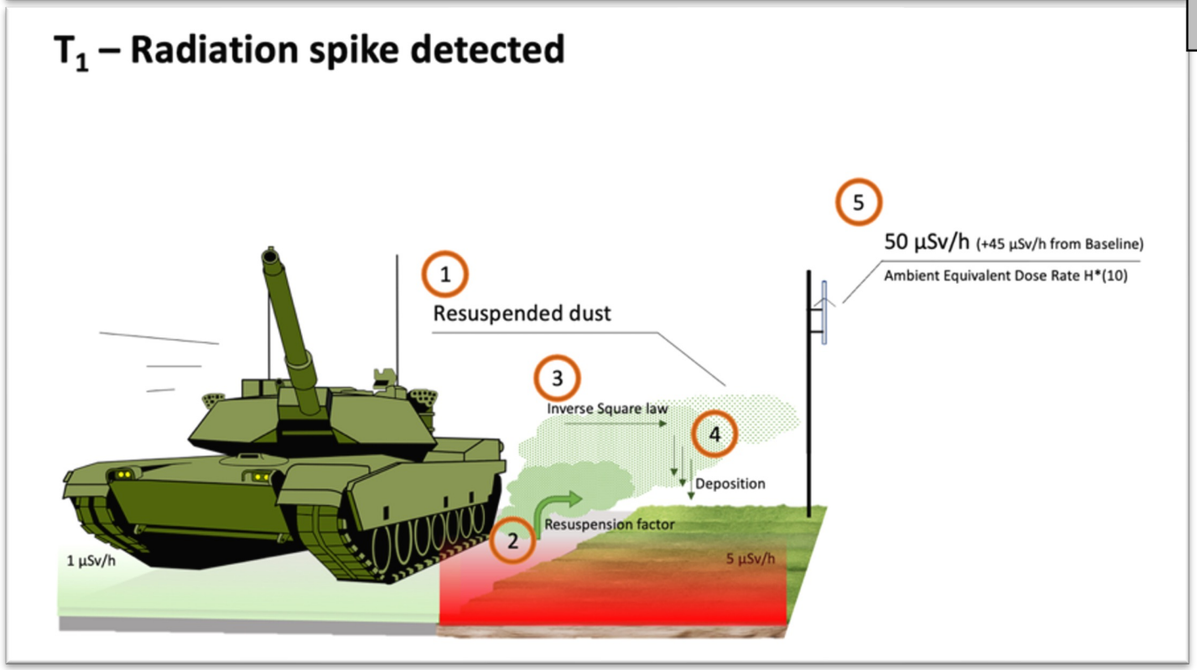
However, its maximum H*(10) value recorded in 2020 was 1,5 μSvh^{-1}, far from the expected 50 μSvh^{-1}.

7	Пожежне депо	1700	1900	2000	1800	4800
8	ВРП - 750	1200	1300	1500	1200	4500
9	АПК-1	390	470	530	440	1400



1. The H*(10) level measured in the decontaminated road is 5 times lower than in the nearby contaminated soil. Although this is a sample value, it matches real ratios mentioned by the IAEA for the CEZ.
2. In our example the GammaTRACER is located really close to the road.
3. The H*(10) recorded by the GammaTRACER is mainly calculated from the ^{137}Cs found in the contaminated soil.
4. The contaminated soil reports a baseline of 5 µSv/h
5. The ^{137}Cs located in the upper layer is the main contributor to the baseline level.

Let's look at these two images to provide a visual summary of the issue. The indicated H*(10) levels (1, 5 and 45 and 50 µSv/h) do not correspond to any specific station, they are just sample values to illustrate the reasoning, although similar to those officially reported. Please also note that the distances between the elements depicted in the following diagrams are not to scale



1. When the heavy military vehicles pass over the decontaminated road, they will resuspend potentially contaminated dust.
2. The number of resuspended materials is determined by the resuspension factor, which for an intense activity (such as digging) may reach 10^{-8}. Regular activities will have a resuspension factor an order of magnitude lower.
3. The radionuclides stuck to the dust particles will emit gamma radiation whose intensity decreases according to the inverse square law.
4. The resuspended dust particles will be deposited according to their aerodynamics and climatological conditions.
5. The GammaTRACER reaches a level of 50 µSv/h. This means that the resuspended ^{137}Cs is contributing to the total H*(10) with an additional 45 µSv/h. Obviously, this is not possible, coming from a decontaminated road whose baseline is just 1 µSv/h

The ‘return to baseline levels’ mystery (I)

Why did the stations return to their baseline levels just few days after the spikes?

According to the ‘resuspension of soil’ theory we have that, either the resuspended materials that caused brutal increments of the H*(10) while airborne, stopped being gamma emitters after the regular deposition phase, or there was no deposition phase at all. Both cases would be equally unphysical. This scenario, in turn, leads to the following **never-ending circular problem**: How is it possible to achieve higher levels of H*(10) just by resuspending the same materials that were already present in the top layer of the soil?

There are two options:

1. An external release from a radioactive source.
2. A resuspension activity with a massive transport involved.

It is the consensus that the first option never happened. So, we are left with the second one. However, if there was a significant transport (relocation) of radioactive materials, large enough to achieve the reported H*(10) levels: Why did the stations return to their baseline levels just few days after the spikes? And so on.

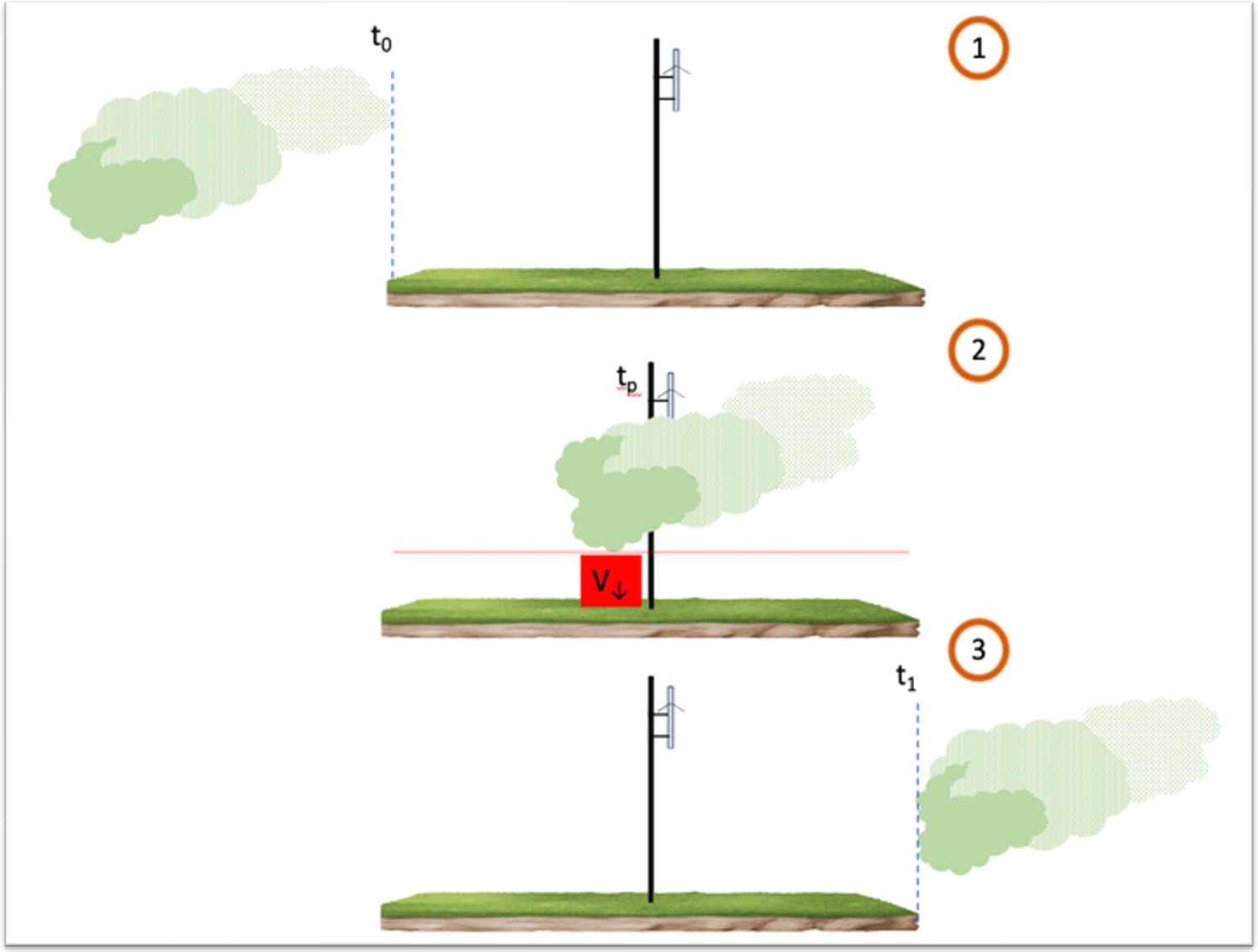
The ‘return to baseline levels’ mystery (II)

In this context, the ‘Contamination of Surfaces by Resuspended Materials’ paper provides, in a single sentence, a simple and intuitive, but still scientific, refutation to the ‘resuspension of soil’ theory

The total horizontal flux $J_{\rightarrow}$ is important as it is the quantity finally leading to migration of hot spots; it is given by $J_{\rightarrow} = \int_0^{\infty} j_{\rightarrow}(z)dz$ (2. 18)

Note that a non-zero total horizontal flux does not necessarily mean that net - resuspension takes place: in resuspension - deposition equilibrium gains from one side equal losses on the other side. On the other hand, at concentration steps, horizontal fluxes may be important vectors of contaminant transport into clean areas.

Basically, what has been reported in the Chernobyl Exclusion Zone is an unprecedented case in nuclear physics: an unbalanced resuspension scenario without a deposition phase



Timestamp	Ambient Dose Equivalent Rate (nSv/h)
Feb 24, 2022 – 18:00:00	1760
Feb 24, 2022 – 20:00:00	1760
Feb 24, 2022 – 20:40:00	8790
Feb 24, 2022 – 21:00:00	1760
Feb 24, 2022 – 21:50:00	9460
Feb 25, 2022 – 10:50:00	32300
March 1, 2022 – 15:00:00	1740
March 1, 2022 – 16:00:00	1740

1. At $t_0 < t_p$
   The plume comprised of the resuspended materials has not yet reached the area of detection for the GammaTRACER.
2. At t_p
   Resuspended radioactive materials have reached the GammaTRACER, thus provoking a peak. $V_\downarrow$ indicates the deposition velocity (in this case, the lack of).
3. At t_1
   The plume has left the area of influence for the GammaTRACER, which has then returned to its previous baseline level.

$V_\downarrow$ is effectively 0

a. V_i (eddy diffusion)
b. V_s (sedimentation – Stokes' law)

No particles involved, the gravitational force was neglected, or the air increased its density to a value close to a solid state.

5. Technical Analysis of the ‘Cyber’ Operation

Anomalies – The Six Stations

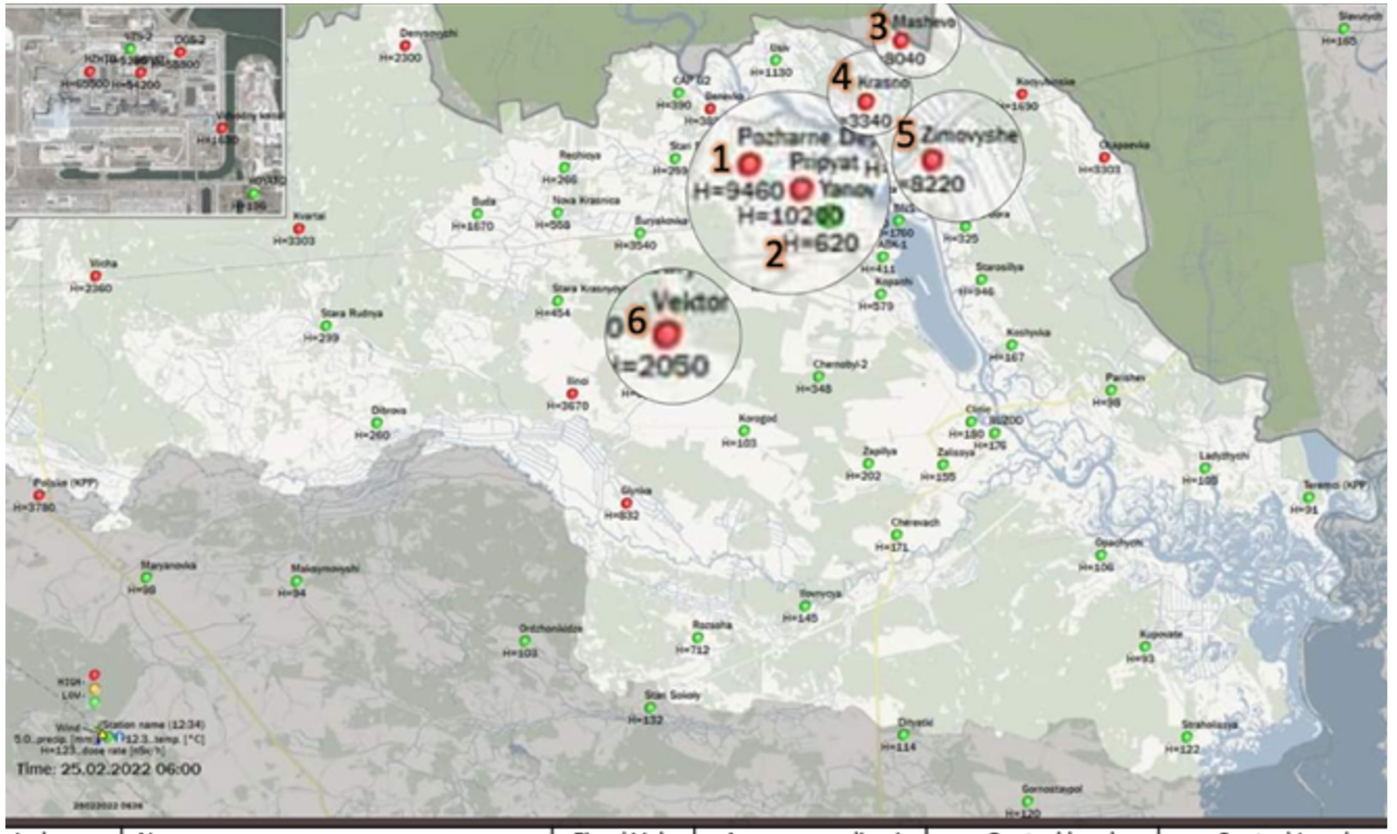
The SNRIU only reported to the IAEA the H*(10) values of six specific stations. A practice for which I am yet to find a logical explanation, bearing in mind those values did not come from manually taken measurements, but directly from the ASKRS system.

№ п/п	Назва пункту	Зафіксоване значення	Середнє значення за 2021 рік	Контрольний рівень	Перевищення Контрольного рівня
1	Пожежне депо	9460	1900	4800	2,0
2	Станція Янів	3460	670	1700	2,0
3	Машево	8040	840	2200	3,6
4	Красне	3340	720	2000	1,7
5	Зимовище	8220	780	2100	3,9
6	Вектор	2050	130	270	7,6

Anomalies – The Six Stations

The SNRIU only reported to the IAEA the H*(10) values of six specific stations. A practice for which I am yet to find a logical explanation, bearing in mind those values did not come from manually taken measurements, but directly from the ASKRS system.

However, the spike for the Yanov Station (3,46 $\mu Sv h^{-1}$) was never recorded by any of the publicly available sources for radioactivity levels in the CEZ at that moment



Index	Name	Fixed Value	Average reading in 2021	Control level	Control Level exceeding factor
1	Pozharne Depo	9460	1900	4800	2,0
2	Yanov Station	3460	670	1700	2,0
3	Mashevo	8040	840	2200	3,6
4	Krasno	3340	720	2000	1,7
5	Zimovyshe	8220	780	2100	3,9
6	Vektor	2050	130	270	7,6

Anomalies – The Six Stations

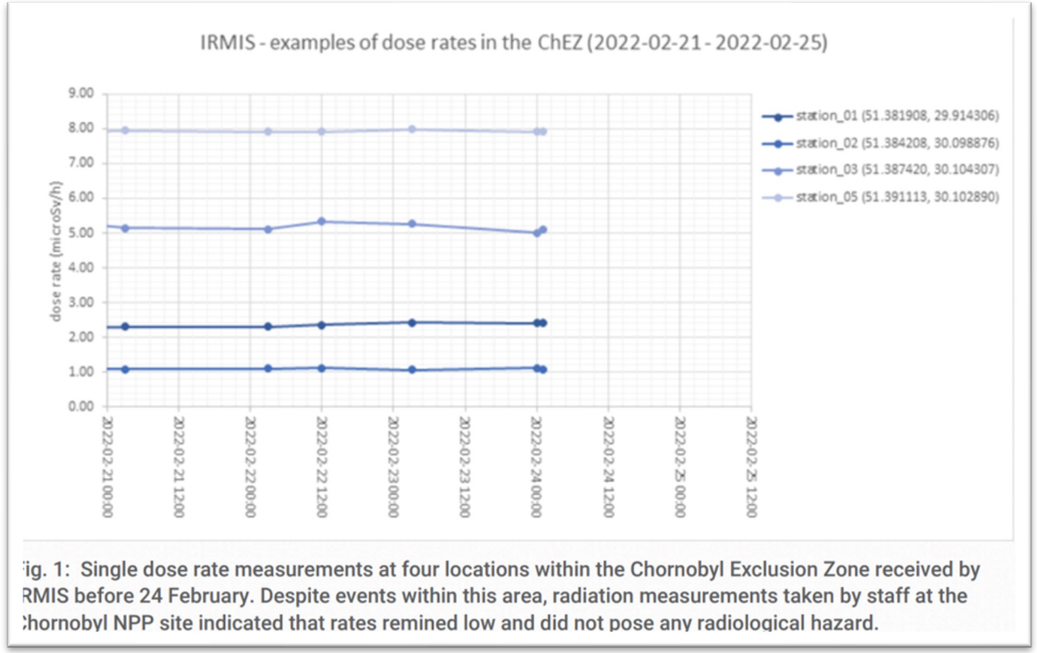
One of the main questions is why SNRIU did not report the following values of three regulatory stations which were way higher, also collected from the same ASKRS system.

	device_id	phenomenon	value	logged_at
DGS-2	3732	gamma	58800.0000	2022-02-24 21:50:00
HZHTO	3733	gamma	65500.0000	2022-02-24 21:50:00
HOYAT	3734	gamma	54200.0000	2022-02-24 21:50:00

Obviously, I do not know the answer, neither do I want to speculate on the reasons. However, it is worth noting that these unreported radiation spikes are coincidentally in the range of the Operational Intervention Levels (OIL) for reactor emergencies and spent fuel ($OIL2_{\gamma}$, 25 µSv/h – 100µSv/h).

“An OIL is a type of action level that is used immediately and directly (without further assessment) to determine the appropriate protective actions on the basis of an environmental measurement.”

Some of these measurements from the Chornobyl Exclusion Zone indicated an increase in the gamma dose rates that was attributed to the displacement of soil due to heavy machinery movements in the area. Based on these data, the IAEA assessed radiation levels as low and within the operational range measured in the exclusion zone since it was established, and therefore considered that they posed no hazard to the public. (IAEA, 2022)

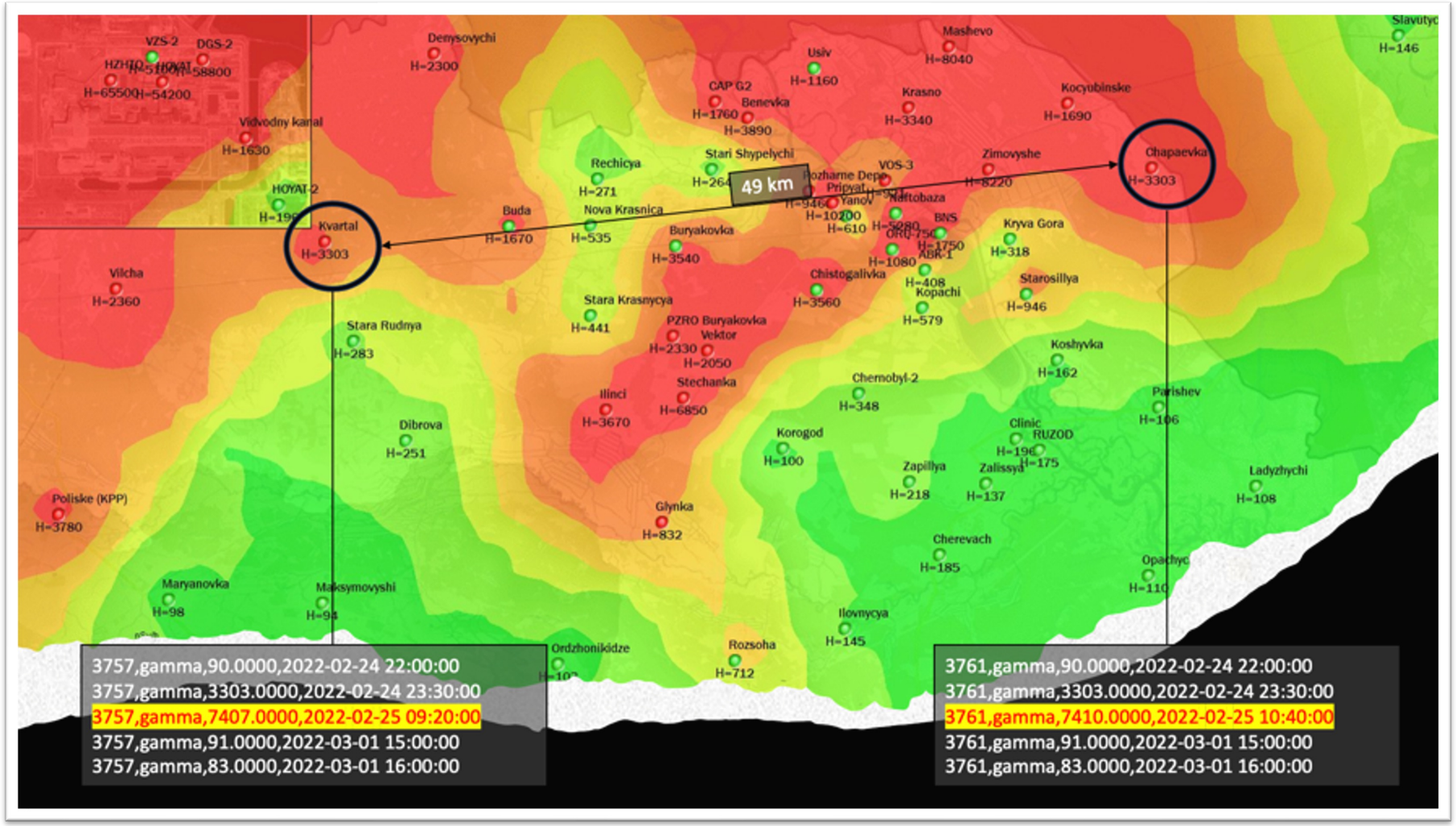


ig. 1: Single dose rate measurements at four locations within the Chornobyl Exclusion Zone received by RMIS before 24 February. Despite events within this area, radiation measurements taken by staff at the hornobyl NPP site indicated that rates remined low and did not pose any radiological hazard.

The graph used by the IAEA in their report shows H*(10) levels close to those reported by the SNRIU. However, the stations do not match (Buryakovka VRP-750,VZS-2,DGS2).

It should be noted that in this report the IAEA only assessed the values that were officially reported to them by the SNRIU. They did not take into consideration, at least publicly, the remaining radiation spikes the general public was observing on the Ecocentre Website.

Anomalies – The ‘Twin Stations’ CHAPAEVKA and KVARTAL

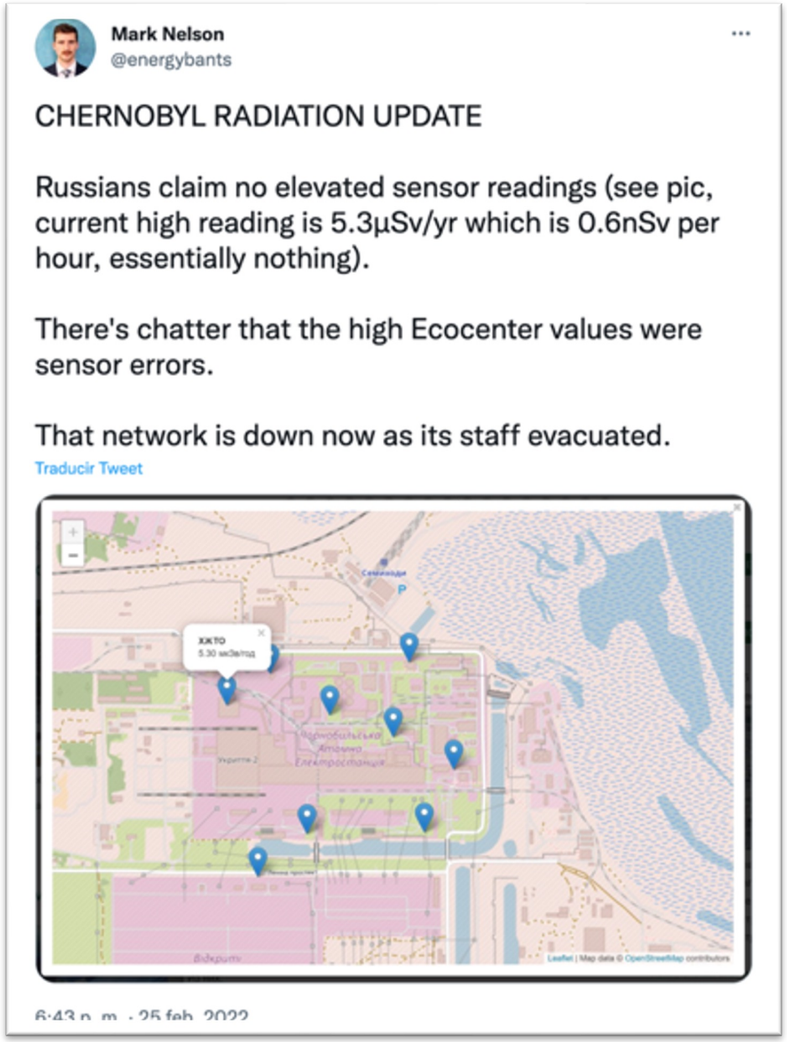


On December 23rd 2020 at 6:00 PM these stations started reporting the same H*(10) at the same timestamps. Probably this was caused by some kind of misconfiguration that was prolonged in time.

In roughly 14 months, there were only two times when these two stations reported different H*(10) values at different time stamps

1. January 3rd, 2022
2. February 25th , 2022

Anomalies – The ‘ChNPP’ Radiation Monitoring Network



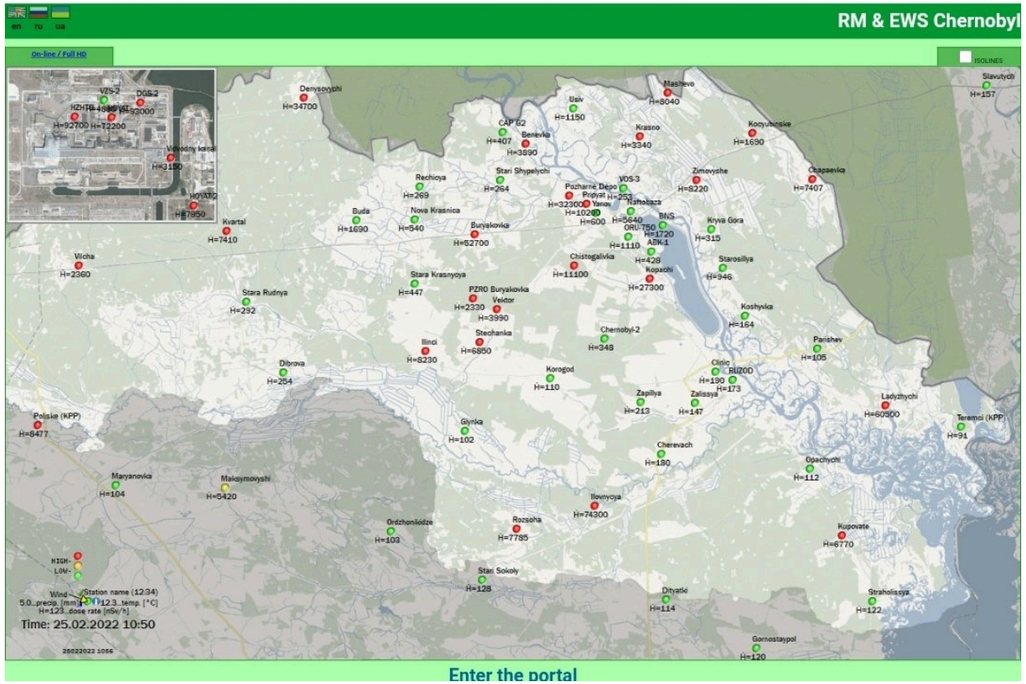
In addition to the radiation monitoring network operated by SSE Ecocentre, inside the CEZ there is another, separate, radiation monitoring network limited to the Chernobyl NPP area, which is operated by SSE ChNPP.

The monitoring stations in this network did not report any abnormal radiation levels, even when Ecocentre’s stations located really close to them were actively reporting spikes.

The ‘spike-and-offline’ approach to manipulate real-time radiation monitoring information

The Ecocentre real-time radiation map provided a chunk of base64-encoded data for each station when new readings were available. Otherwise, the last received reading is kept in the map; if this reading is above the station’s control level, a red dot will indicate the alarm status.

```
<area shape="circle" coords="859,198,10" alt="Kryva Gora"  href="javascript:popup('popup.php?
data=VGltZTo9MDk6MDB8RGF0ZTo9MjUuMDIuMjAyMnxBbWJpZW50IChEb3NlIHJhdGUpPTMyNyBuU3YvaHxMYXRpdHVkZT1QMDUxLjM4NDg1M3xMb25naXR1ZGU9RTAzMC4yMDExOTU,&
location=S3J5dmEgR29yYQ,,','Station_data','859','198','128','189');" >
```



The ‘spike-and-offline’ approach to manipulate real-time radiation monitoring information

The plausible manipulation pattern would be as follows:

1. A fabricated spike is generated by software and injected into the ASKRS at the DataEXPERT level.

2. This spike is then populated to the Ecocentre website.

3. Legitimate readings still coming from the GammaTRACER probes are blocked from being populated to the Ecocentre website. This is the reason why the stations went ‘offline’ after reporting spikes.

4. As there are not new values, the Ecocentre radiation map will keep showing the last received reading for each station (in the map the stations will keep the ‘red dot’ associated with the last spike received).

By injecting these radiation spike patterns, the actors behind this operation would ensure that the real-time radiation map available at srp.ecocentre.kiev.ua, whose stations were only updated when new data was received, represented the information they wanted at specific times.

Those stations that, during the 24th, did not record any radiation spikes, received the values at the expected rate. For instance, we can see this pattern in the measurements below, which correspond to Yanov Station. This confirms that the entire system was not offline, but only those stations reporting spikes.

```
3745,gamma,600.0000,2022-02-24 11:00:00
3745,gamma,592.0000,2022-02-24 12:00:00
3745,gamma,606.0000,2022-02-24 13:00:00
3745,gamma,598.0000,2022-02-24 14:00:00
3745,gamma,594.0000,2022-02-24 15:00:00
3745,gamma,582.0000,2022-02-24 16:00:00
3745,gamma,580.0000,2022-02-24 17:00:00
3745,gamma,594.0000,2022-02-24 18:00:00
3745,gamma,600.0000,2022-02-24 19:00:00
3745,gamma,592.0000,2022-02-24 20:00:00
3745,gamma,590.0000,2022-02-24 21:00:00
3745,gamma,604.0000,2022-02-24 22:00:00
3745,gamma,590.0000,2022-02-24 23:00:00
3745,gamma,594.0000,2022-02-25 00:00:00
3745,gamma,610.0000,2022-02-25 01:00:00
```

There are 4 different patterns of manipulated measurements:

1.- Spikes injected at one time
A unique spike is reported, and the station goes offline.
This pattern was identified in 18 stations:
Naftobaza, VOS-3, HOYAT-2, Kopachi, Usiv, PZRO Buryakovka, Chernobyl-2, Starosillya, Vilcha, CAP G2, Glynka, Kocyubinske, Ladyzhychi, Nova Krasnica, Stechanka, Kupovate, Ilovnycya, Maksymovyshi.

2.- Spikes injected at two times
Two spikes are injected following an incremental logic: the first spike is always lower than the second. No additional readings in between (offline).
This pattern was identified in 17 stations: DGS-2, HZHTO, HOYAT, Chistogalivka, Pripyat, Buryakovka, Mashevo, Zimovyshe, Krasno, Benevka, Vektor, Ilinci, Chapaevka, Denysovychi, Kvartal, Poliske (KPP), Rozsoha.

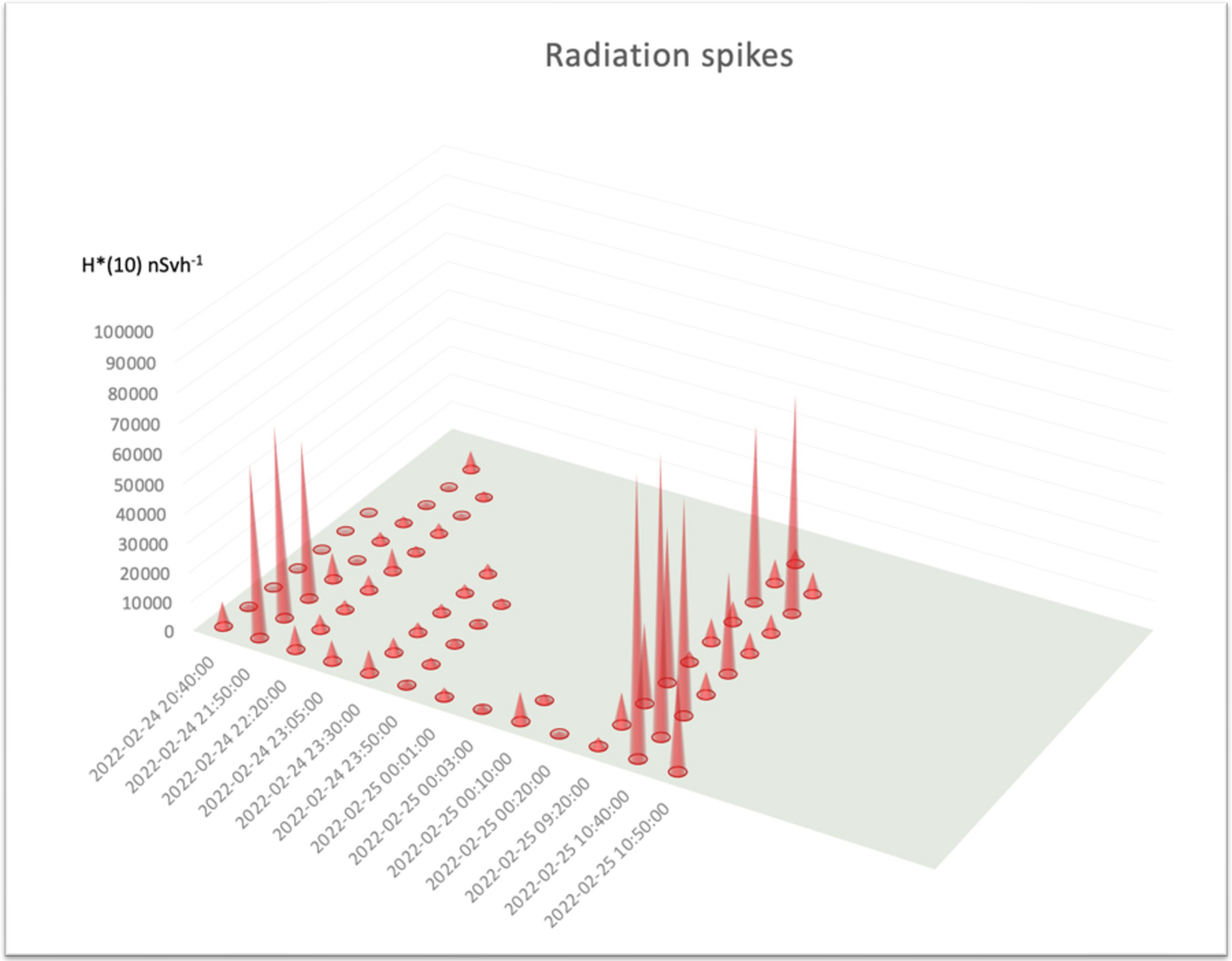
3.- Spikes injected at three times
Three spikes are injected following an incremental logic.
This pattern was identified in 2 stations: Pozharne Depo and Vidvodny kanal.
There is a particularity in Pozharne Depo, where what seems like a legitimate baseline value slipped in after the first spike. Please note the timestamp for this value is a regular one (the corresponding hourly o'clock time) rather than one of the 13 timestamps.

3743,gamma,1760.0000,2022-02-24 20:00:00
3743,gamma,8790.0000,2022-02-24 20:40:00
3743,gamma,1760.0000,2022-02-24 21:00:00
3743,gamma,9460.0000,2022-02-24 21:50:00
3743,gamma,32300.0000,2022-02-25 10:50:00

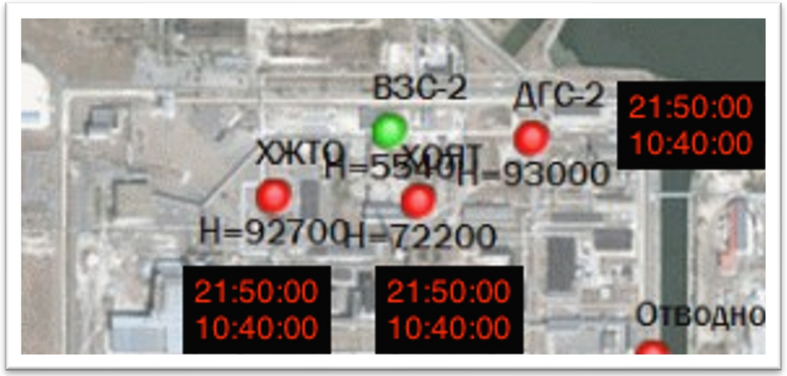
4.- Spike and decrease
A spike is injected, and the next injected value is lower than the spike.

This pattern was identified in 5 stations, which were among the first seven to report spikes on February 24th: Ordzhonikidze, Diyatki, Gornostaypol, Straholissya, Teremci (KPP).

On Feb 24th, all of them, although separated by tens of kilometers, reported a spike at 8:40 PM, and then a decrease in the radiation level at 11:30 PM.



During the time that SaveEcoBot and OPYT collected data from the Ecocentre website, until 10:50 AM of the 25th, there were 13 fixed timestamps when 63 spikes were detected.



For instance, the three highest radiation spikes detected within the Chernobyl NPP area, were recorded at the same exact timestamps 21:50 (Feb 24) and 10:40 (Feb 25), without receiving any other reading within this interval.

6. Analysis of Potential Attack Scenarios

There are three patterns in the data that plausibly denote an intentionality behind the radiation spikes:

1. **Timestamps**
   Instead of being dispersed in time, we have seen how the spikes were reported in different batches comprised of just 13 different timestamps. In certain cases, up to 10 different stations, separated by tens of kilometers, reported spikes at exactly the same time.
2. **Online/Offline**
   As it has been elaborated in the previous section, the stations reporting spikes did so by following four different, structured patterns. Patterns 1 and 2 were identified in 83% of the stations that detected radiation spikes.
3. **Radiation Levels**
   The ambient equivalent dose rate allegedly transmitted by the GammaTRACER did not represent the actual physical conditions in the CEZ.

	Timestamps	Online/Offline	Radiation Levels
EMI	Extremely Unlikely	Extremely Unlikely	Extremely Unlikely
RF Induced voltage	Extremely Unlikely	Extremely Unlikely	Extremely Unlikely
SkyLINK Spoofing	Certain	Likely	Certain
Malware	Certain	Certain	Certain

EM ATTACK AGAINST CENTRAL PROCESSING STATION

It is reasonable to assume that EM warfare equipment was, at some point, used during the invasion. The ‘Primary Data Center’, the server where DataEXPERT software and its MS SQL Database are installed, could also have been exposed to unintentional EMI patterns coming from RF equipment present in the area during the invasion.

However, it is not realistic to assume that either EM warfare or arbitrary electromagnetic emanations could have caused, with a surgical precision, non-transient high-level behaviors, such as changing tens of specific values in a database installed into a modern, complex IT system.

EM ATTACK AGAINST SKYLINK

Unintentional

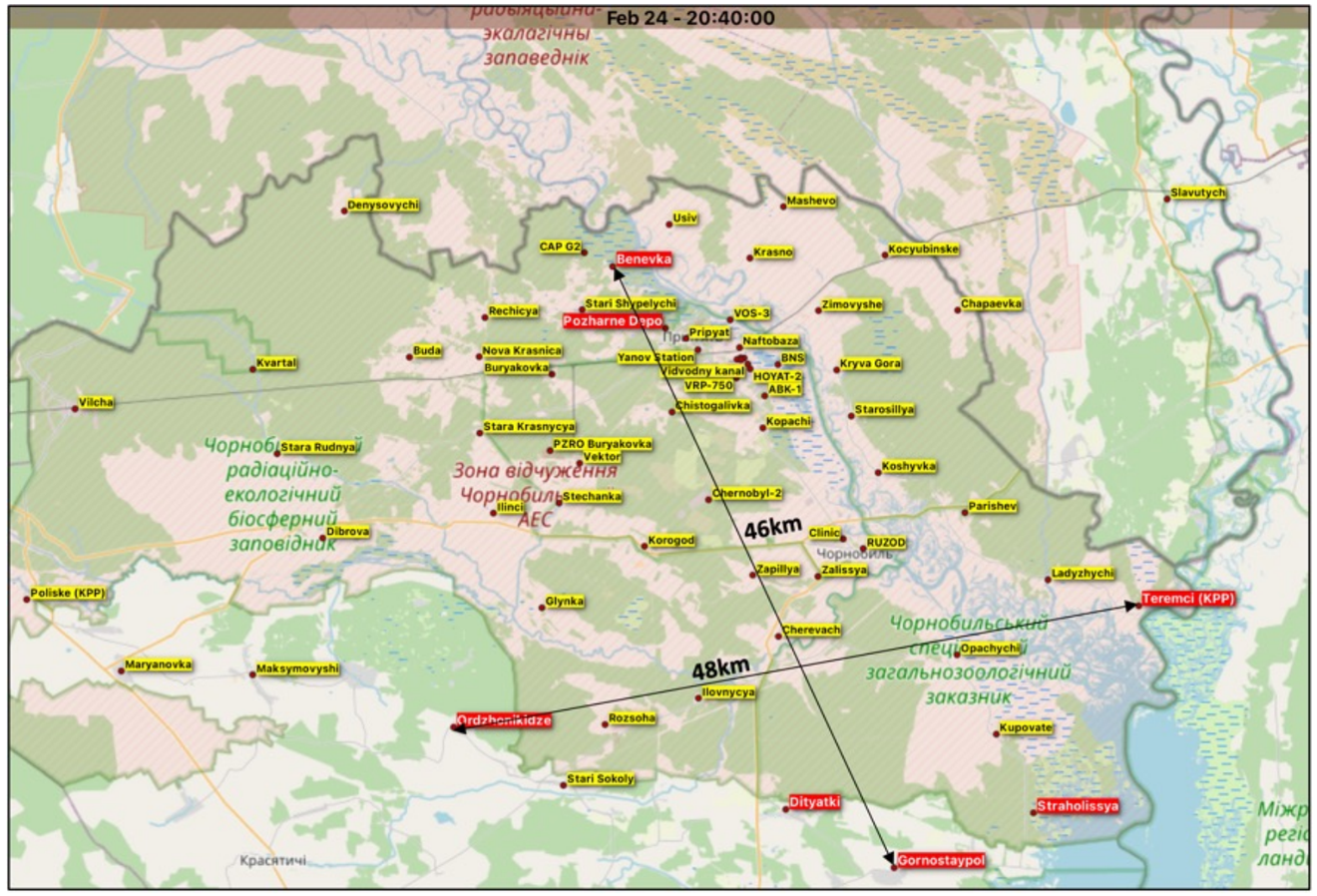
By ‘unintentional’ I mean as ‘collateral damage’ from either an EMI attack pattern targeting other systems or arbitrary electromagnetic emanations. First of all, it should be noted that there were no reports of EM pulses or any other system failures derived from directed energy weapons.

SkyLINK is a digital communication system. The RF signals received by the base station go through different stages of decoding and verification. Therefore, the side-effects of the EMI pattern should be able to successfully modify frames in a complex, custom RF protocol (SkyLINK), which has a very specific structure, including checksums.

Additionally, the unintended EMI patterns should have been able to precisely corrupt only selected beacons from certain stations, those that went ‘offline’, while those transmissions coming from the stations that did not report spikes were successfully received, decoded, and verified by the base station.

RF-INDUCED VOLTAGE

There is another scenario where the EMI attack pattern could have created a RF induced voltage into the electronics that handles the pulse counting from the Geiger-Müller



1. The GammaTRACER probes and the SkyLINK transmitter module are specifically designed to mitigate EMI

2. Any artificially injected pulse should be generated according to very specific timings required to comply with the deadtime and recovery intervals for the GammaTRACER's Geiger-Müller tubes, which are in the microseconds range

Additionally, the Chernobyl Exclusion Zone covers ~2600km^2. In a significant number of cases, the radiation monitoring stations reporting spikes were many kilometers apart from each other. This means that we are talking about a potential electromagnetic induction derived from way beyond any antenna's initial far-field

There is no coherent spatial distribution for the potential radiated EM pattern, as the other stations in the area did not report anomalies.

RF-INDUCED VOLTAGE

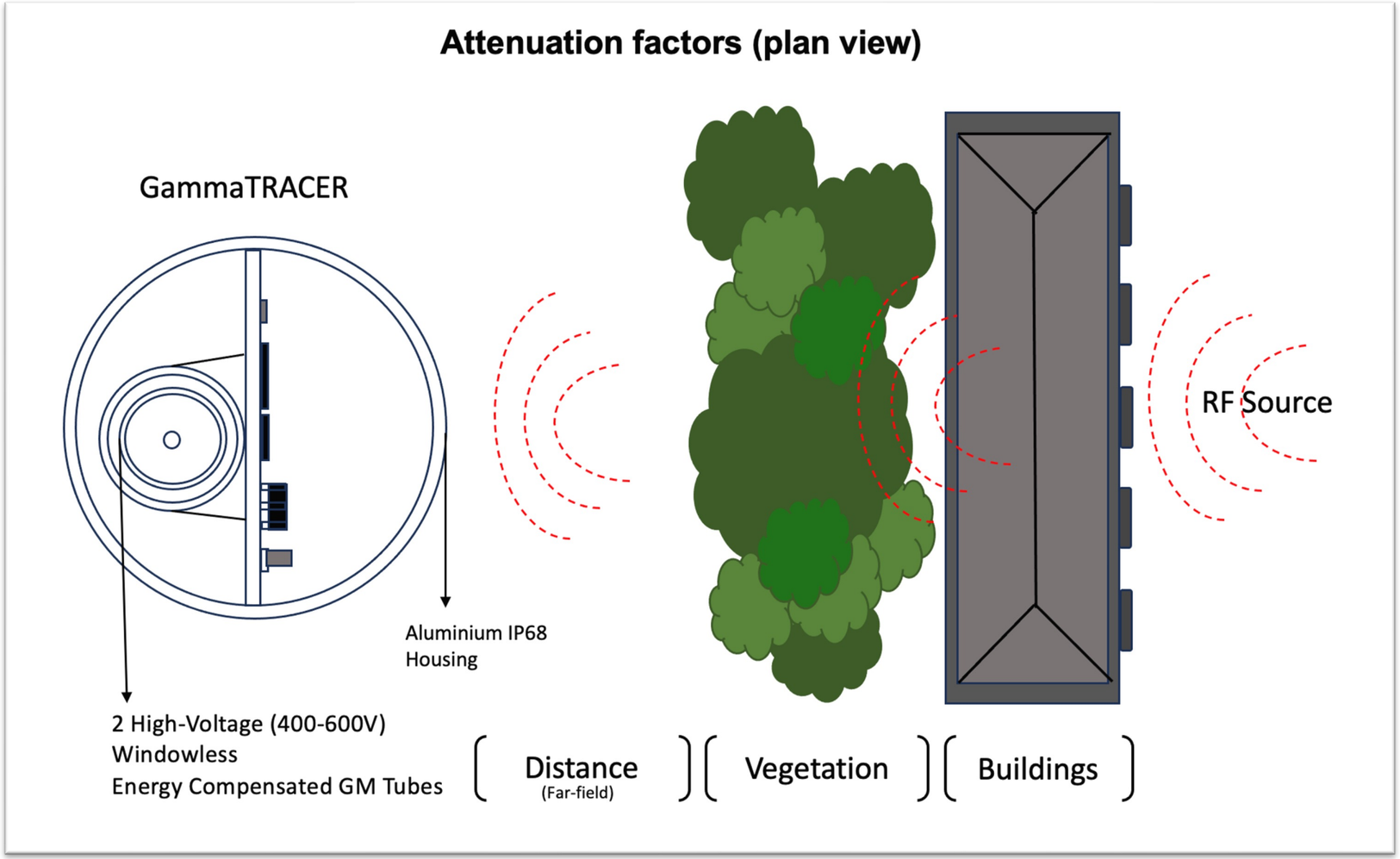
There are additional countermeasures in firmware, in fact there is one we can validate by reverse engineering DataEXPERT/DataVIEW, as data transmitted by the GammaTRACERs contains a ‘quality status’ word, which adds context to the readings

```
cProtocol_StatusGT cprotocol_statusgt2 = this.pStat;
cprotocol_statusgt2.xmlS = new StringBuffer().append(cprotocol_statusg
String[] strArr = {"NVAL1", "NVAL2", "NVAL3", "NVAL", "OVR", "ECHO1",
String[] strArr2 = {"NVAL1", "NVAL2", "NVAL", "OVER", "SPIKE", "EMI",
String[] strArr3 = {"DATAREAD", "TIMESET", "CHDEAD", "HUM", "SHOCK", "
String[] strArr4 = {"EMI/COINC", "SPIKE", "RAIN", "MAINT.XL", "LIGHTN"
for (int i51 = 0; i51 < i && this.pStat.DescDT[i51] != 0; i51++) {
    String cvalue = this.pStat.Values[i51].toString();
```

GammaTracer has a built-in quality assurance system which continuously compares the two GM detectors to ensure that they are consistent and verifies other operating parameters. Any irregularity is logged in the probe's memory and flagged by a marker in the displayed area, once this is downloaded. The nature of the irregularity can then be investigated by the user.

https://energy.ec.europa.eu/system/files/2015-01/tech_report_sweden_0.pdf

UNEXPECTED IONIZATION EVENTS



As it has been previously introduced, the GammaTRACER contains two Energy Compensated Geiger-Müller tubes. These models are designed to operate with a potential between the cathode and the anode within the 400-600 V range. These tubes also lack a window, usually present in the GM tubes that also respond to alpha and beta particles, thus preventing low-energy, spurious EMI, from easily reaching the gas chamber.

Being equipped with energy-compensated and windowless tubes means that the GammaTRACER is only designed to respond to high-energy ionization events (45 kEV to 2000 kEV), resulting from either X-Rays or Gamma radiation

SKYLINK SPOOFING

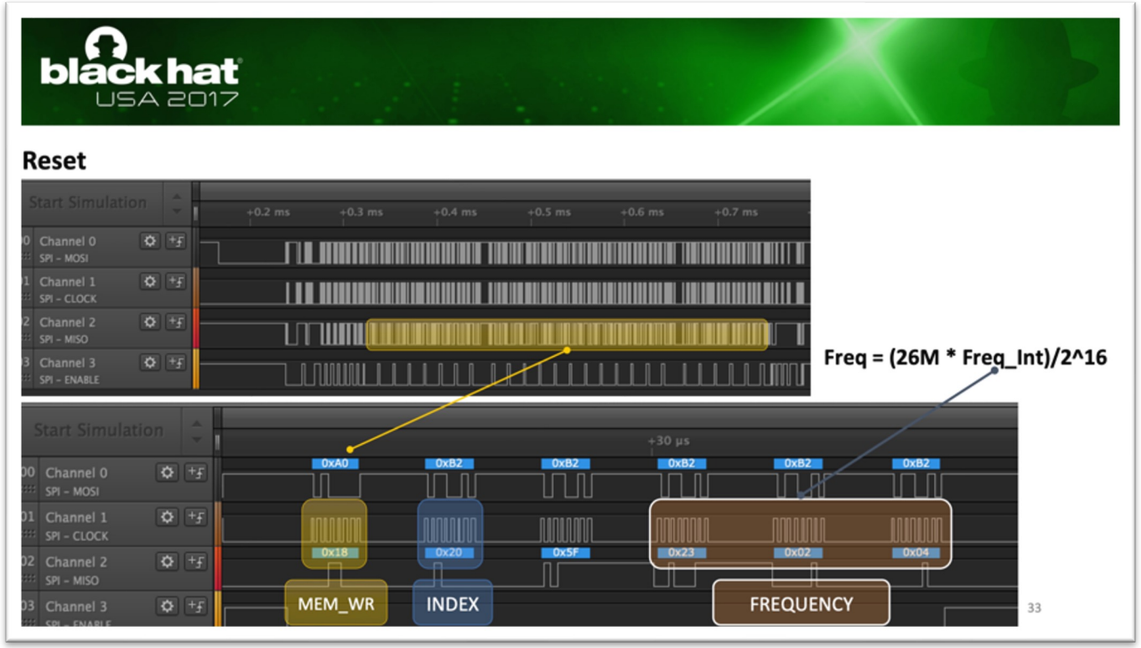
As I see it, this is very much the same scenario I elaborated during the Mirion's WRM2 research, but adapted to Bertin's SkyLINK, as we have the same elements: a custom RF protocol, a base station and software ingesting the readings.

Radio

The idea is, to be able to replicate the RF custom protocol of a Software Defined Radio (SDR), you need to characterize the protocol, modulation, encoding, frequencies, frame contents, and so on

Firmware

Usually, the most time-efficient approach is to capture (i.e., by tapping into the SPI bus, as in the slide below) the configuration loaded by the MCU into the RF transceiver. In order to do this, we just need to buy the same commercial RF transceiver used by the target device, inject the configuration we sniffed for that particular custom protocol and we will have a fully functional transceiver for our own purposes.



MALWARE

I am using the term ‘Malware’ here purely to mean a piece of software that implements a potentially malicious logic. As a result, it should not be inferred that this software has been deployed by an adversary nor should one assume its origin.

- It is a likely assumption that the Central Processing Station was, somehow, manipulated.

- it would then be a trivial matter to forge radiation levels at will as we have seen. This data would then be populated to other systems (e.g., scraped by saveecobot.com).

- The DataEXPERT architecture (Database + acquisition modules + main program) makes it an easy target, so the malware would not have to be anything very sophisticated either.

- Additionally, the fact that the Central Processing Station ‘disappeared’ does not help particularly in invalidating this option.

I reached out to Juan Andrés Guerrero-Saade, a security researcher who managed to find the AcidRain wiper back in March 2022. The idea I had was to explore the, unlikely, possibility of finding the potential malware based on certain specific information (strings, database fields, paths…) collected by reversing DataEXPERT. As expected, nothing was found

7. Conclusions

1. The abnormally high ambient equivalent dose rate (H*(10)) levels, detected during the 24th and 25th of February 2022 by the Automatic Radiation Monitoring System (ASKRS) of the Chernobyl Exclusion Zone, were plausibly fabricated.

2. From a nuclear physics perspective, these radiation spikes cannot be explained as a response of the GammaTRACER radiation monitoring devices to a traffic-induced resuspension of contaminated dust in the Chernobyl Exclusion Zone.

3. Instead of being detected due to ionizing radiation processes, the H*(10) values, corresponding to the allegedly detected radiation spikes, were plausibly injected into the ASKRS network infrastructure at 13 different determined timestamps, following a specific set of software-generated patterns.

4. As a result of this plausible manipulation, the radiation levels (H*(10)) depicted by the real-time maps provided by saveecobot.com and srp.ecocentre.kiev.ua, did not correspond to the actual physical conditions in the area. During the period, these maps were consulted by millions of people, and also consumed as a single source of information by media outlets and official entities.

Among the unusual reactions, or simply the lack of them, there is a decisive one for which I could not initially find a logical explanation

During the radiological incident of the CEZ there were two important events that attracted all the headlines: abnormally high radiation spikes and Russian soldiers digging trenches in the vicinity of the Red Forest. Coincidentally, the IAEA just analyzed the latter. The radiation spikes were barely mentioned in their technical reports or press conferences. This is a notable anomaly, as this approach goes against their own emergency response guidelines and past incident reports .

This task required significant efforts and resources.

88. During the mission, IAEA experts conducted initial radiation monitoring in the Chornobyl Exclusion Zone, including in the reported excavations, and collected environmental samples for analysis. Dose rate measurements were taken at about 10 cm and 1 m above the ground.

89. All the environmental samples mentioned above were measured by high resolution gamma spectrometry and by inductively coupled plasma mass spectrometry at the IAEA's Safeguards Analytical Laboratories and the Terrestrial Environmental Radiochemistry Laboratory.

However, nothing can be found about the estimated doses for the hundreds of Ukrainian workers (and Russian soldiers) located within the Chernobyl NPP area.

There, the ambient equivalent dose rate (according to the reported radiation spikes) reached levels over 60 μSv/h for more than 12 hours, and over 90 μSv/h for at least 4 hours. higher than the annual public dose limit (1 mSv), absorbed in less than 24 hours.

There is no mention of samples collected from the Chernobyl NPP area either. Therefore, anyone who assumes the radiation spikes were real, after reading the IAEA reports, would be bound to believe in the fanciful scenario where a resuspension-based radiological incident, able to generate ambient equivalent dose rates of 93 μSv/h (within the range of certain Operational Intervention Levels), left no deposition traces.

As a result, it must be assumed that the IAEA experts were more worried about a trench than about radiation spikes recording radiation levels higher than those detected after the Fukushima-Daiichi NPP accident. This is hard to believe, unless obviously, the nuclear safety experts from the IAEA silently concluded that the radiation spikes never actually happened.

Then one could ask why the IAEA did not come forward to clarify the situation about these radiation spikes. As I see it, the main reason is because at that moment, the IAEA would have likely been required to provide a proper explanation. This is the Gordian knot of this whole issue, not because of its technical difficulty, which is far from being a challenge for the nuclear experts who work at the IAEA, but likely due to its geopolitical implications.

THANK YOU!

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