From:	Doug Hartnett
To:	Angus, Neil; Lowitt, Peter
Cc:	Kristen Cullen; Anne Columbia; Tyson Reynoso; Quitzau, Curtis; Carola, Marc
Subject:	111 Hospital Road - CFS responses to requested IPS compliance
Date:	Sunday, January 17, 2021 7:02:11 PM
Attachments:	External CFS Safety and IPS.msg CFS Magnet Factory Materials and Chemicals.pdf EMI_1486700_PR Model magField_site.pdf EMI Memo_01-15-2020.pdf Campus Headcount Projections.xlsx

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Neil:

In response to your 01/07/21 email attached, the CFS team has been working to address your questions regarding demonstrating compliance with the Industrial Performance Standards for CFS-1 and CFS-2. I would like to rephrase the points outlined in your email, and provide responses accordingly in red. In addition there are attachments for your review to support our conclusions.

Emissions:

- Still need the full Air Quality Assessment in order to complete the review
    - VHB submitted an Air Quality Assessment for CFS-2 with the original Unified Permit application. The Assessment concludes that the CFS-2 Project will not exceed any of the Air Quality Permit threshold requirements. CFS-1 has conducted a preliminary assessment and do not anticipate exceeding Air Quality Permit thresholds. The CFS-1 team is coordinating with the CFS-2 team to document a comprehensive Air Quality Assessment for both facilities, and will submit this to DEC staff for review prior to or during building permit review.
- When looking at air quality, we need to see all chemicals AND quantities that could be emitted from both CFS-1 and CFS-2. There are numerous exhaust fans mentioned in the sound study so we need to understand what is coming out of those (particulate matter/dust, odor).
    - VHB submitted a chemical storage summary list with the original CFS-2 Unified Permit application under Appendix H – Water Resource Protection District Memorandum. Attached you will find a materials inventory for CFS-1 prepared by Commonwealth Fusion for your review. CFS-1 and CFS-2 each have their own chemical and material storage areas and there is no current plan to have them commingled. For hazardous waste, the plan is for each building to have its own "satellite accumulation area" with separate pickups, and will not be centralized within the campus.
- Demonstrate how both projects combined are below MassDEP air permitting thresholds. Those thresholds are 50 tons per year of VOC or NOx, 10 tons per year of a single HAP, 25 tons per year of combined HAPs, and 100 tons per year of any other pollutant.
    - The CFS-1 and CFS-2 teams are preparing a revised Air Quality Assessment to demonstrate that both projects combined do not exceed the Air Quality Permit thresholds and meet the requirements of the IPS. This will be submitted for DEC staff for review prior to or during building permit application review.
- Please provide the level of alpha, beta, and gamma radiation associated with the normal operations of CFS-1 and CFS-2 and what happens if there is any malfunction. We understand if there is a leak, air gets in, the fusion reaction ceases and the radiation dissipates. But please provide actual calculations of radiation generated and emissions that would be associated with the 10 second tests.
    - CFS-1 is a magnet manufacturing facility and will not contain any radioactive materials nor produce any radiation. The CFS-2 research and development facility is still in the process of being designed, so exact estimates for alpha, beta, and gamma radiation levels cannot be completed at this time. This will depend upon facility engineering design, materials selection, and operational procedures which will not be finalized for some time. However, CFS-2 is being designed to meet all public health safety standards associated with radiological materials and CFS will undergo a comprehensive licensing process with the Massachusetts Radiation Control Program (MRCP) through the Department of Public Health prior to commencing operations of CFS-2. Compliance with the MRCP regulations requires an analysis of potential radiological exposure to occupational workers as well as members of the public who may be present at or in the vicinity of CFS-2. The model analyzes the design specifications for the operations for CFS-2 with respect to site-specific topography and meteorological variables, quantifying potential radiological releases under both normal operating and accidental release scenarios. While not finalized, the preliminary model simulations demonstrate that CFS-2 will not exceed DPH/MRCP regulatory thresholds for allowable exposure, falling well below the defined limits.

Electromagnetic:

- Output needs to be evaluated cumulatively for CFS-1 and 2.
    - VHB submitted an Electromagnetic Interference (EMI) assessment for CFS-2 with the original Unified Permit application - Section R. – Compliance with Industrial Performance Standards. An updated assessment summarizing EMI output cumulatively for CFS-1 and CFS-2 is attached with this email for DEC staff review. The conclusion is that the magnetic field intensity at the property line is below typical background levels and therefore mitigation is not required.

Lighting:

- DEC Regulations require a reduced level of illumination during 11pm-7am. If operations are proposed during this time, please provide an updated lighting plan.
    - A revised site lighting plan was submitted with the 01/07/2021 revised site plan submission responding to original comments from DEC and peer reviewers. The following protocols will be instituted to reduce illumination levels between

11pm-7am to comply with this Requirement:

a. All exterior lighting will be controlled via a building lighting control panel with external daylight photocontrol sensor and integrated timeclock.
b. Parking lot lighting zones will be programmed to turn on at dusk and turn off at 11:00pm via the lighting control panel.
c. Between 11:00pm and 7:00am (or dusk) parking lot lighting will be turned on when an occupancy sensor located integral to the parking lot lighting fixtures is activated. After a set period of time of no activity, and not longer than 30 minutes, the fixture will turn off.
d. Building entrance lighting will be programmed to turn on at dusk and turn off at dawn via the lighting control panel and external daylight photocontrol sensor.

Sound Study:

- Please provide all raw hourly background sound data ASAP. Please also clarify what hours you are assuming for daytime, evening, and nighttime periods.
- Please provide modeling files ASAP.
- Vibration also needs to be evaluated as part of sound.
    - The CFS team and their acoustic consultant Vibrasure, have been working with the DEC's peer review consultant, TEC Environmental to prepare a comprehensive analysis of ambient background noise conditions, and acoustic noise modeling of both CFS-1 and CFS-2 during normal daytime and nighttime operations to demonstrate compliance with the IPS. For CFS-1 the consultant has determined that noise levels associated with currently specified rooftop mounted mechanical equipment exceed maximum allowable noise thresholds at a few of the predetermined sensitive receptors. The team is evaluating options for reducing noise levels to comply with the IPS including available equipment acoustic damping retrofits, alternate equipment selection with lower noise output, and/or structural mitigation measures such as roof mounted acoustic screen walls. The team will submit an updated noise assessment to the DEC's peer reviewer for review and comment prior to the next scheduled public hearing on 01/19/2021.

Hours of Operation

- A number of the above issues also hinge on the CFS-1 and 2 hours of operation. Please provide additional details as requested on the proposed hours of operation, shifts, and # of employees per shift.
    - Commonwealth Fusion has prepared a projected employee occupancy matrix by department and shift, which is attached as an Excel spreadsheet. The matrix provides projections for monthly, quarterly, and half year operations as campus employment expands with the occupancy of CFS-1 and CFS-2, respectively through 2025.

Not listed in your email, but noted in the staff review notes, was a request for clarification of the shift occupancy vs. parking demand to verify the proposed 288 parking spaces are appropriate for the use of both facilities. The attached occupancy an shift matrix projections inform the anticipated parking demand. As noted by CFS the assumption for parking demand is as follows:

- Projected employee headcount = 373 (105 factory + 268 office)
- Projected employee occupancy at any given time: 321
- Projected number of people in building = 321 (CFS employees) + 20 (collaborators) + 20 (visitors) + 3 (factory vendors) = 364
- **Adjusted number of people taking into consideration absenteeism, remote working, and alternative transportation = 364 - absences - alternative transport = 283 parking demand.**

The below table was previously submitted for review by the DEC regarding parking demand, and reconciles with the 283 space minimum parking projection. The CFS-1 project provides 288 spaces building in a 1%-2% contingency.

OFFICE AREA KEY DRIVERS

The following assumptions were made to project the required site parking associated with the Magnet Factory & HQ building:

	HC	Temporarily Working Offsite	Absences	HC Onsite - Absences	Alternative Transport*	Parking Stalls
Factory Staff	105	0%	5%	100	n/a	n/a
Factory Staff / Shift	53	0%	5%	50	15%	42
Factory Vendors	3	0%	5%	3	0%	3
Office / Engineering Staff	268	5%	5%	242	15%	206
Office/Eng Collaborators	20	5%	5%	18	10%	16
Visitors (public spaces)	20	0%	0%	20	20%	16
Total / Shift	**364**			**333**		**283**
Total	**416**			**383**		**n/a**

All assumptions in this document are a reflection of the very flat and collaborative organization CFS is trying to create. Office and open work spaces shall be designed according to the following:

1. Private offices are generally reserved for the few people that have regular, confidential conversations.
2. With few exceptions, employee workstations are monolithic in size and appointment to reflect a single "class" of employee. This is a daily reminder that everyone's contributions are valued by the company and important to its mission.

Please contact me directly if you have further questions,

Best regards,
Doug

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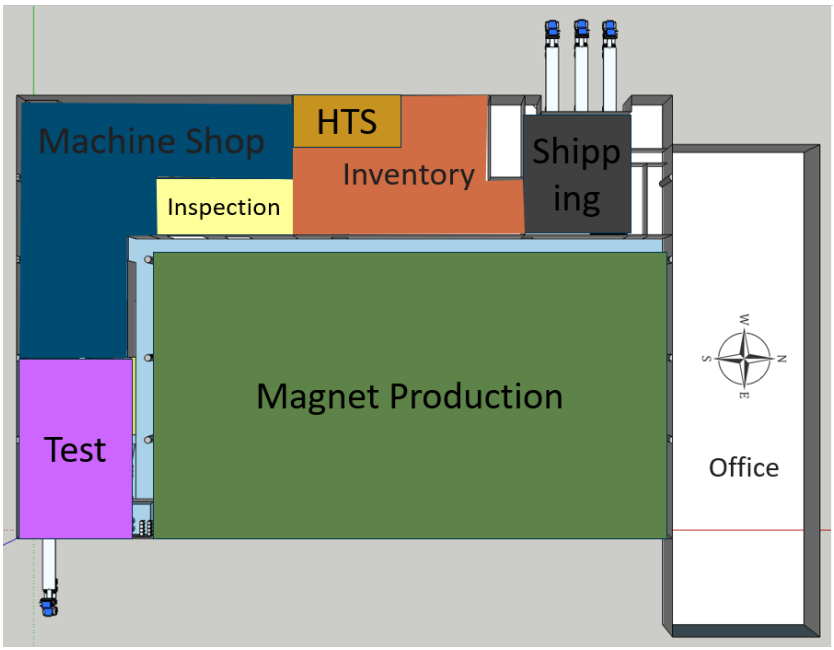
CFS- 1 | Magnet Factory Materials & Chemicals Inventory - January 2021



Overview of Building Work Centers

- **Shipping & Receiving:** Area to load and unload multiple goods from trucks using forklifts, hand trucks, or other equipment. Other processes such as packing, unpacking, and routing goods to appropriate storage areas will be performed. Shipping & Receiving will also be the storage area for machine shop chip waste.
- **Inventory:** Area to store received raw materials, external vendor parts, finished goods, equipment spares, and chemicals safely. Operation of forklift, hand truck or other equipment to load, unload, transport, and store goods are required. Processes such as unpacking, sorting, inspection, and kitting will also be performed.
- **HTS:** Area that tests the HTS (high temperature superconductor) tape at different temperatures (using liquid nitrogen or gaseous helium) and magnetic fields.
- **Machine Shop:** Area where large pieces of raw material are machined into final production part forms; it also has general-use equipment to support prototyping. Equipment includes mills, lathe CNC machines, waterjet, and other smaller machines. Other general machine shop capabilities will be welding and hand-tool use.
- **Precision Inspection:** Area to measure parts to verify that they meet specifications and to test structural components at cryogenic temperatures. Inspection may be performed either with hand-held tools (e.g., micrometers, height gauges) with a granite surface plate or with a coordinate measuring machine (CMM). The testing of components will be performed with an Instron testing system.
- **Magnet Production:** Area comprised of multiple work stations to build the sub-assemblies and superconducting magnets for SPARC and other applications. Processes include mechanical assembly, cleaning, welding, VPI (vacuum pressure impregnation), and electrical testing in liquid nitrogen.
- **Magnet Testing:** Area to test all magnets before they are shipped to the SPARC assembly hall or other end users. For testing, the magnets are inserted into a sealed vacuum vessel with cryogenic fluids (GN2, LN2, GHe) run through it in a closed loop cycle.

Materials & Chemicals Details by Work Center

Work Center	Description	List of Materials	Volatile Organic Compound, Acids, Bases	Notes
Shipping and Receiving	Area to load and unload multiple goods from trucks using forklifts, hand trucks, or other equipment. Other processes as packing, assembly of crates, unpacking, and route goods to appropriate storage areas will be performed.	Numerous listed within the work centers, Wood, Steel, Aluminum, Plastics	--	See appendix for info on machine shop chip waste.
Inventory	This area is designated to store received raw materials, external vendor parts, finished goods, equipment spares, and chemicals safely. Operation of forklift, hand truck or other equipment to load, unload, transport, and store goods are required. Processes such as unpacking, sorting, inspection, and kitting will also be performed.	Numerous listed within the work centers, Wood, Steel, Aluminum, Plastics,	--	--
HTS	Area that tests the HTS (high temperature superconductor) tape at different temperatures (using liquid nitrogen or gaseous helium) and magnetic fields.	Lead plated HTS tape, LN2 - two 230L tanks, GHe - one 291L tank, solder	1 gal max at a time of: Acetone, Ethanol, IPA, Flux	Portable solder fume extractors are used to draw air away from the operator and filter out hazardous materials before returning the air to the atmosphere.
Machine Shop	Area where large pieces of raw material are machined into final production part forms; it also has general-use equipment to support prototyping. Equipment includes mills, lathe CNC machines, waterjet, and other smaller machines. Other general machine shop capabilities will be welding and hand-tool use.	Steel alloys, Aluminum alloys, Copper, Plastics, Composites (incl. fiberglass laminates)	Acetone (10 gal at a time), Ethanol (1 gal max at time), IPA (1 gal max at time), Machine coolants, Cutting fluids	See appendix for additional information about machine shop chip waste and VOCs.
PI - Precision Inspection	Area to measure parts to verify that they meet specifications and to test structural components at cryogenic temperatures.	Steel alloys, Aluminum alloys, Copper, Plastics, Composites (incl. fiberglass laminates), LHe (one 60L Dewar)	Acetone (10 gal at a time), Ethanol (1 gal max at time), IPA (1 gal max at time)	--

Work Center	Description	List of Materials	Volatile Organic Compound, Acids, Bases	Notes
Magnet Production Work Station 1	Work station to mechanically build the superconducting magnets for SPARC.	Stainless steel alloys, Copper, Solder Wire, Thermocouple wire, Stainless steel, Aluminum, Lead plated HTS tape	RTV silicone (2 lbs/month) IPA (6 gal max at a time, 12 gals/month) Ethanol (3 gal max at a time, 6 gals/month)	--
Magnet Production Work Station 2	Work station to clean subassemblies and mechanically build the superconducting magnets for SPARC.	Copper, Kapton Tape, High Temp Silicone, Solder Wire, Solder Paste	RTV silicone (5 lbs / month) Solder Paste (5 lbs/month) Citranox (25 gal max at a time, 50 gal/month) Acetone (3 gal max at a time, 6 gals/month) Ethanol (3 gal max at a time, 6 gals/month)	Citranox waste requires proper disposal.
Magnet Production Work Station 3	VPI (vacuum pressure impregnation) of the magnets in an oven.	Teflon, stainless steel, aluminum, RTV silicone, Copper, Brass, Argon, Flux, Solder, Electrically Conductive Silicone, Nitrogen/Hydrogen gas mixture, Silicone Rubber, RO Water, Heat Transfer Fluid, fiberglass, Cryogenic epoxy	Flux - 40 gallons per week Heat Transfer Fluid (recirculating) – 110 gallons RTV silicone – 2 gallons per week Nitrogen/Hydrogen gas mixture (5% Hydrogen)	VPI process generates lead remnants that will be properly disposed. Oven exhaust contains only hot air with no VOCs and drainage contains only RO water.
Magnet Production Work Station 4	Work station to clean subassemblies and mechanically build the superconducting magnets for SPARC.	Solder, Copper, Silver plating, Kapton tape, Indium wire, Aluminum, Copper	Ethanol (3 gal max at a time, 6 gals/month) Apiezon (vacuum) grease (4 oz /month) Citranox (25 gal max at a time, 50 gals/month) Silver plating	Citranox waste requires proper disposal.
Magnet Production Work Station 5	Work station to test the superconducting magnet subassemblies for SPARC.	LN2 (140 cu. ft. per week), Stainless steel, Aluminum, G-10CR, Kapton tape	--	--
Magnet Production Work Station 6	Work station for final integration of the SPARC magnets.	Fiberglass, Stainless steel, Aluminum, Copper, Indium wire	IPA (3 gal max at a time, 6 gals/month), Ethanol (3 gal max at a time, 6 gals/month), Welding gas TBD (argon, helium, acetylene, propane, or butane), Welding fumes	--

Work Center	Description	List of Materials	Volatile Organic Compound, Acids, Bases	Notes
Magnet Production Work Station 7	Work station to clean subassemblies and mechanically build the superconducting magnets for SPARC.	Copper, Kapton, Citranox, Water, Lead Plated HTS, Stainless steel tubing, Fiberoptic cable, Polyimide film	Citranox (25 gal max at a time, 50 gal/month) IPA (3 gal max at a time, 6 gal/month)	Citranox waste requires proper disposal.
Magnet Production Work Station 8	VPI (vacuum pressure impregnation) of the magnets in an oven.	Teflon, stainless steel, aluminum, RTV silicone, Copper, Brass, Argon, Flux, Solder, Electrically Conductive Silicone, Nitrogen/Hydrogen gas mixture, Silicone Rubber, RO Water, Heat Transfer Fluid, fiberglass, Cryogenic epoxy, epoxy, hardener, accelerator	Flux - 20 gallons per week, Heat Transfer Fluid (recirculating) – 55 gallons, RTV silicone – 2 gallons per week, Nitrogen/Hydrogen gas mixture (5% Hydrogen), Epoxy - 400 gallons every other month, Hardener - 330 gallons every other month, Accelerator - 1 gal every other month	VPI process generates lead remnants that will be properly disposed. Oven exhaust contains only hot air with no VOCs and drainage contains only RO water.
Magnet Production Work Station 9	VPI (vacuum pressure impregnation) of the magnets in an oven.	Stainless steel, epoxy, hardener, accelerator	Epoxy - 800 gallons every other month, Hardener - 660 gallons every other month, Accelerator - 2 gal every other month	Any potential epoxy remnants require proper disposal. Oven exhaust contains only hot air with no VOCs.
Magnet Production Work Station 10	Work station to clean subassemblies and mechanically build the superconducting magnets for SPARC. Processes include VPI (vacuum pressure impregnation) of the magnets in an oven and electrical testing in liquid nitrogen.	Stainless steel, Copper, Solder wire, Thermocouple wire, Aluminum, Lead plated HTS tape, Kapton, Citranox, Water, Solder, Teflon, RTV silicone, Brass, Argon, Flux, Electrically Conductive Silicone, Nitrogen/ Hydrogen gas mixture, Silicone Rubber, Heat Transfer Fluid, RO Water, fiberglass, Cryogenic epoxy	RTV silicone -5 lbs/month, IPA - 3 gal max at a time, 6 gals/month, Ethanol - 3 gal max at a time, 6 gals/month, Solder Paste - 3 lbs/month, Citranox - 15 gal max at a time, 30 gal/month, Acetone - 3 gal max at a time, 6 gals/month, Flux – 10 gallons per week, Heat Transfer Fluid (recirculating) – 55 gallons, Nitrogen/Hydrogen gas mixture (5% Hydrogen), Cryogenic Epoxy - 100 gallons per month	VPI process generates lead remnants that will be properly disposed. Any potential epoxy remnants require proper disposal. Oven exhaust contains only hot air with no VOCs and drainage contains only RO water.
TEST - Magnet Testing	Area to test all magnets before they are shipped to the SPARC assembly hall or other end users. For testing, the magnets are inserted into a sealed vacuum vessel with cryogenic fluids (GN2, LN2, GHe) run through it in a closed loop cycle.	GN2 (13 cu. ft. at 2500 psi), LN2 (none stored in area but plumbed from 11,000 gal tank outside building), GHe (26 cu. ft. at 2500 psi)	IPA (5 gal max at time), Ethanol (5 gal max at time),	--

Appendix: Machine Shop Additional Information

Chips

As parts are machined from stock into their final form, the removed material accumulates as "chips". This adds up as a substantial amount of waste to be stored / disposed of in a machine shop. A rough chip mass of 150 kg / week of steel is estimated. These chips will be collected from the machine shop and stored in approved waste containers in the Shipping & Receiving area for disposal/recycling pickup.

Metalworking Fluids (MWFs) & Air Quality

The greatest air quality concern in a machine shop is the worker skin or airborne exposure to metalworking fluids (MWFs). Metalworking fluids are widespread within any machine shop, serving to cool and lubricate surfaces during machining. MWFs range from the recirculated coolants within large, enclosed CNC machines to low volume, manually applied cutting fluids. Excess exposure may lead to adverse health effects including skin and lung irritation, decreased lung function, and a variety of cancers [1] [2] [3]. Based on studies of asthma and diminished lung function, OSHA & NIOSH have each recommended exposure limits of 0.5 mg/m^3 total particulate mass over time weighted averages of 8 hours or 10 hours, respectively [1]. From an equipment and infrastructural standpoint, CFS intends to follow the recommended exposure limit through continuous monitoring of the air with VOC meters, selection of low VOC coolants, machine-level mist collectors, and shop-level air scrubbers.

Given our intended approach of continuous monitoring with on-machine & shop-wide air filtration systems to meet recommended exposure limits, the following collection of links are included to provide information on different equipment options being considered.

<u>VOC Meters</u>

- Purpose: Monitor particulate mass throughout the machine shop.
- Example: PCE Instruments https://www.pce-instruments.com/us/measuring-instruments/test-meters/air-quality-meter-pce-instruments-air-quality-voc-meter-pce-voc-1-det_5852842.htm?_list=kat&_listpos=7

Note these are relatively inexpensive, available, and can provide the desired mg/m^3 measurements.

<u>Low VOC Coolants</u>

- Purpose: The coolants being recirculated in the CNC machines will be the majority of metalworking fluids in the machine shop. Selecting a low VOC coolant is then a large contributor to keeping within the target particulate level.
- Example: Hocut 795-B from Houghton International Inc. is a common coolant for aerospace applications. The Hocut line in general emphasizes biostability and non-misting for coolant longevity.
    - https://www.houghtonintl.com/sites/default/files/resources/houghtonmetalworking_products_brochure_.pdf
    - Safety datasheet found here: https://www.houghtonintl.com/en/products/hocut%C2%AE-795-b-13
    - https://www.houghtonintl.com/en/resources/metalworking-fluid-solutions-aerospace-industry
    - https://www.acculube.com/houghton-metalworking-fluids.html

Low volume MWFs

- Purpose: The remainder of metalworking fluids will be other cutting fluids in the machine shop albeit in much lower volumes than in the large machines. These would be used in manual, individual applications such as applying tapping fluid before tapping a hole to add threads; these operations are ideally infrequent in production.
- Example: McMaster Tapping and Threading Lubricants https://www.mcmaster.com/tapping-fluids/tapping-and-threading-lubricants-6/
    - Note that the general product descriptions for Mobil & Rapid Tap each mention resisting misting while Tap Magic cannot be sold to California for exceeding VOC limits.

Mist Collectors

- Purpose: Machine-level air filtration of oil/mist from metalworking fluids
- Examples:
    - Technology overview article https://www.ctemag.com/news/articles/clearing-air
    - Air Quality Engineering https://www.air-quality-eng.com/applications/metal-machining/

Industrial Air Cleaners

- Purpose: Shop-level air filtration
- Examples:
    - Air King filtration http://airkingfiltration.com/
    - Blue Ox air cleaners https://www.blueoxaircleaners.com/

References

[1] OSHA Metalworking Fluids: Safety and Health Best Practices Manual https://www.osha.gov/metalworking-fluids/manual#d
[2] CDC Metalworking Fluid Exposure at an Aircraft Engine Manufacturing Facility – Ohio https://www.cdc.gov/niosh/hhe/reports/pdfs/2010-0144-3164.pdf
[3] CDC Evaluation of exposures and respiratory health concerns in a paper converting equipment manufacturing facility https://www.cdc.gov/niosh/hhe/reports/pdfs/2012-0055-3337.pdf

Commonwealth Fusion Systems

From: Commonwealth Fusion Systems

To: Devens Enterprise Commission

Title: Magnetic Field at Devens

Date: 01/15/2021

1 Executive Summary

Identification, risk assessment, and possible mitigation strategies for Electromagnetic Interference (EMI) emitted from the proposed test site in Devens is required as part of the permitting process. The primary contributor to EMI has been identified as the tokamak field magnets and the expected magnetic field strength at the nearest property boundary has been analyzed. The expected magnetic field intensity at the nearest property boundary are very low (0.1G or 10uT) and below natural background levels. Thus, additional mitigation of electro-magnetic fields is not required.

2 Response to Questionnaire

As part of the permitting process, a questionnaire is distributed to identify potential environmental concerns. The portion of that questionnaire related to EMI is included below, along with responses from CFS. Supporting calculations are in the following section.

Electromagnetic Interference

Does the proposed project have the ability to create electromagnetic interference?	**YES**	**NO**
46. Have you identified all your potential electromagnetic sources?	**YES**	**NO**
47. Are you proposing to provide spreadsheet calculations of the potential increase in electromagnetic interference and how it will not affect any internal or external receptors as per 974 CMR 4.03(3)?	**YES**	**NO**
48. Are you proposing any mitigation to reduce your overall electromagnetic profile?	**YES**	**NO**
49. Will your project comply with all the electromagnetic requirements under 974 CMR 4.03?	**YES**	**NO**

46 Yes - magnetic field generated during operation of tokamak.

47 Yes - although not in spreadsheet form; calculation is provided below.

48 No - note that mitigation is not necessary due to the results of the calculation.

49 Yes

3 Calculations and Analysis

The most significant potential contributor to EMI from the site in Devens is magnetic fields generated by the electromagnets that are inherent in the fusion device design. Detailed magnetic field modeling has been performed during the preliminary stages of device design and an example is shown in Figure 1 below.

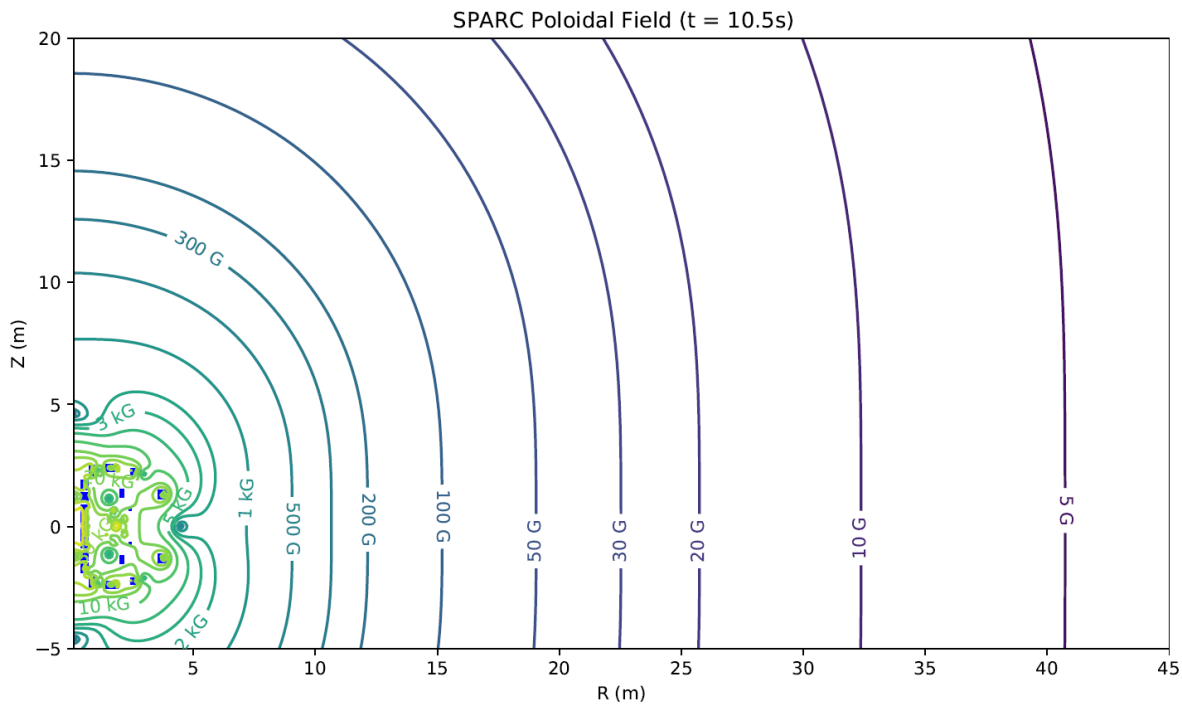


Figure 1. SPARC Poloidal Field

While the field geometry within the device is complex, at distance beyond about ten meters, the magnetic field intensity decreases at a rate proportional to the cube of the distance. This is confirmed analytically using a simplification of the Biot-Savart Law.

The Biot-Savart Law is used to calculate the magnetic field due to an element of a current-carrying wire. When applied to a current loop, the magnetic field is described:

$$B_Z = \frac{\mu_0}{4\pi} \frac{2\pi R^2 I}{\left(z^2 + R^2\right)^{3/2}}$$

Which has an inverse square relationship with distance z. However, at a distance where z >> R, the loop radius becomes insignificant, and the formula follows an inverse cubed relationship with distance z.

4 Results

The nearest property line is 482’ (146.9m) from the centerline of the device. Using the inverse cube law, we can extrapolate the predicted field strength out to that point.

From Figure 1, at 15m we are predicting a magnetic flux density of 100G. At a distance of 146.9m (z2 = 9.79*z1), we should be down about 0.1% (1/(9.79^3)) of the reading at 15m, or about 0.1G (or 10uT). For reference, the strength of a typical refrigerator magnet is 50G or 5mT.

Using the same method of analysis, the boundary for a magnetic field strength of 5G and 0.5G were estimated and plotted in attachment 1 (1486700_PR Model magField.pdf). Magnetic field estimates were included for both the SPARC experiment (CFS-2), and magnet testing performed during manufacturing (CFS-1).

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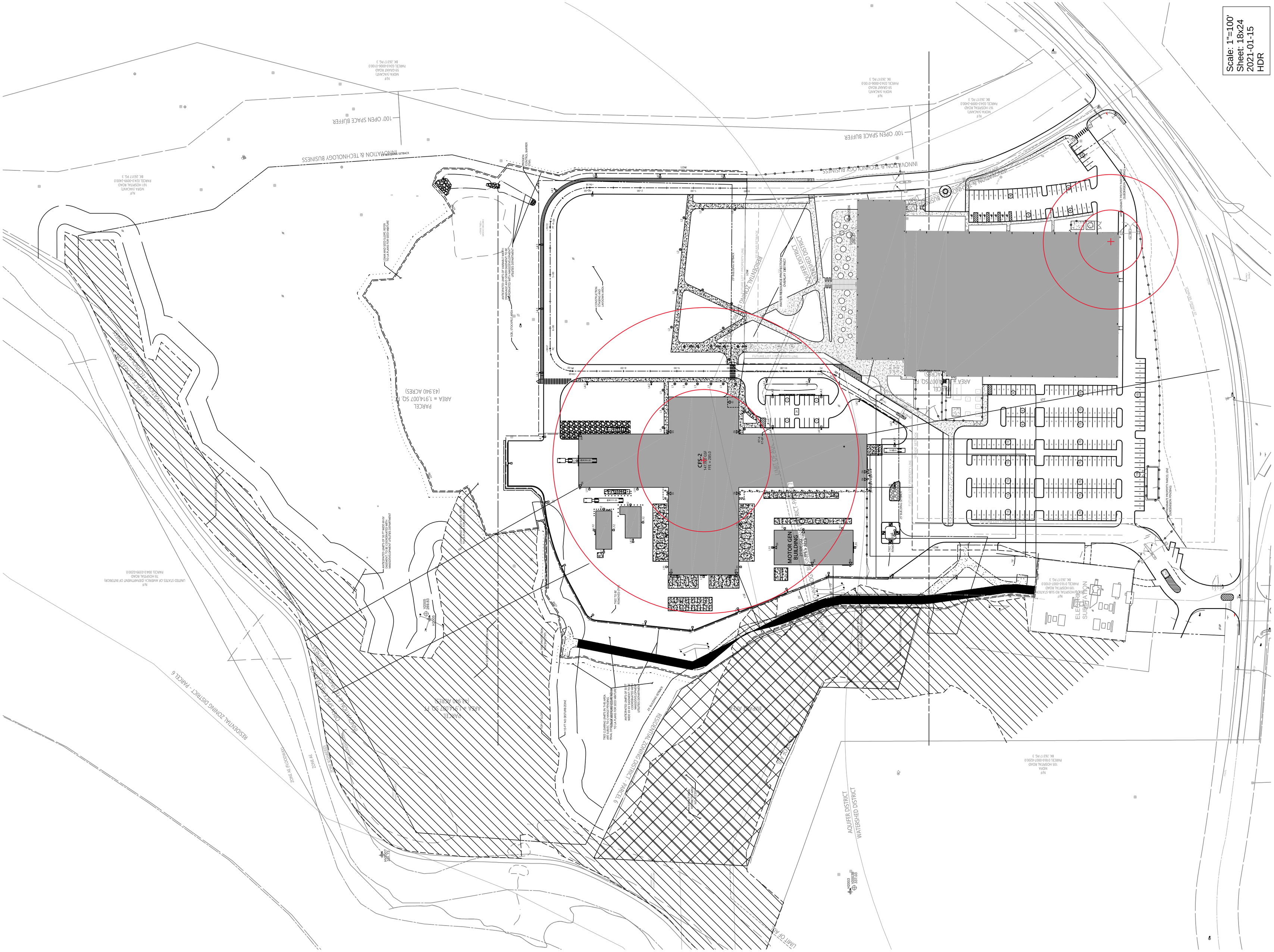
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2021-01-15
HDR
CPS-2
MOTOR GEN BUILDING
ELEVATION
SUBSTATION
AQUIFER DISTRICT
WATERSHED DISTRICT
RESIDENTIAL ZONING DISTRICT
INNOVATION & TECHNOLOGY BUSINESS
100' OPEN SPACE BUFFER
PARCEL
AREA = 1,914,007 SQ. FT.
(43.940 ACRES)
ZONE AE
ZONE AE FLOODWAY
LIMIT OF AREA

Commonwealth Fusion Systems

Campus Headcount

	MAX 373	2020 Q2	2020 Q4	2021 Q2	2021 Q4	2022 Q2	2022 Q4	2023 Q2	2023 Q4	2024 Q2	2024 Q4	2025 Q2
Total Headcount		120	130	167	221	271	312	354	357	361	365	373
Office Workers (~9 am - 6 pm)		116	126	161	186	212	230	249	252	256	260	268
Production Floor Workers (1st or 2nd Shift)		4	4	6	35	59	82	105	105	105	105	105
Building Capacity		118	128	164	204	242	271	302	305	309	313	321