25 July 2017

To: Israel Ministry of Environmental Protection

Dear Sirs,

Regarding the recent inquiries listed below please find my comments further in this paper:

1. Review of fertilizer facilities in the world and how they receive the ammonia,
2. Description of common methods for suppling ammonia to fertilizer facilities across US and Europe,
3. Introduction of how the ammonia supply in the process of fertilizer industry across US and Europe,
4. Example for use of usage of iso-tankers as method to supply anhydrous ammonia in the fertilizer industry as a common mode of operation,
5. Are there sites where the filling of roads-tanks and iso-tankers directly from the importing ship or only trough storage tanks?
6. Is there different in the filling process (the storage condition in the ship and at the shore tank are the same) equipment etc?

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Question

1. **Review of fertilizer facilities in the world and how they receive the ammonia**

Answer:

The Ammonia Industry is large. On a world-wide basis, approximately 550 plants in 80 countries produce ~170,000,000 tons per year of ammonia, having a value of U.S. $40,000,000,000. Many of its modern plants are large, with capacities exceeding 1500 tons of ammonia per day. Its companies produce a limited number of products all of which are commodities with standardized properties; competition is based on price and service.

Approximately 85 percent of the ammonia is used to produce fertilizers.

From our knowledge and research, a vast majority of fertilizer manufacturers benefit of an ammonia plant proximity on site.

A list of existing fertilizer producers in Europe and United States is provided in the table below:

(Note that some of fertilizer producers in US may be on project phase with intention to build in the near future)

***NOTE**: **The assumption is that if stated YES, means that the fertilizer company don't use iso-tankers on a daily basis operation since they have a storage tank on site.**

Country	Name	Ammonia plant with additional storage tank*
Austria	Agrolinz Melamine International GmbH (AMI) I	Yes
Austria	Agrolinz Melamine International GmbH (AMI) II	Yes
Belarus	JSC Grodno Azot I	Yes
Belarus	JSC Grodno Azot II	Yes
Belgium	EuroChem Antwerpen NV	Yes
Belgium	Yara Belgium S.A./NV	Yes
Bulgaria	Agropolychim JSC	Yes
Bulgaria	Neochim PLC	Yes
Croatia	Petrokemija d.d.	Yes
Czech Republic	UNIPETROL RPA, s.r.o.	Yes

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France	Borealis (formerly Produits et Engrais Chimiques du Rhin S.A. (PEC-Rhin))	Yes
France	Borealis (ex GPN)	Yes
France	Borealis (ex GPN)	Yes
France	Borealis (ex GPN)	Yes
France	Yara France S.A.	Yes
France	Yara France S.A.	Yes
Greece	Hellenic Fertilizers & Chemicals ELFE S.A.	Yes
Hungary	Nitrogenmuvek Rt.	Yes
Iceland	Aburdarverksmidjan HF	Yes
Italy	Yara Italia S.p.A.	Yes
Lithuania	SC "Achema"	Yes
Lithuania	SC "Achema"	Yes
Netherlands	OCI Agro I	Yes
Netherlands	OCI Agro II	Yes
Netherlands	Yara Sluiskil B.V. I	Yes
Netherlands	Yara Sluiskil B.V. II	Yes
Netherlands	Yara Sluiskil B.V. III	Yes
Norway	Yara Norway	Yes
Poland	Anwil SA I	Yes
Poland	Anwil SA II	Yes
Poland	ZAK S.A. (ZAK Spolka Akcyjna)	Yes
Poland	Zaklady Azotowe "Pulawy" Spolka Akcyjna	Yes
Poland	Zaklady Azotowe w Tarnowie-Moscicech SA (ZATM) I	Yes
Poland	Zaklady Azotowe w Tarnowie-Moscicech SA (ZATM) II	Yes
Poland	Zaklady Chemiczne "POLICE" SA	Yes

Poland	Zaklady Chemiczne "POLICE" SA	Yes
Romania	Ameropa (formerly S.C. Azomures S.A.) I	Yes
Romania	Ameropa (formerly S.C. Azomures S.A.) II	Yes
Romania	S.C. Amonil S.A.	Yes
Romania	S.C. Azochim S.A.	Yes
Romania	S.C. Donawchem S.R.L.	Yes
Romania	S.C. Nitramonia S.A.	Yes
Romania	S.C. Sofert S.A. Bacau	Yes
Serbia and Montenegro	HIP Azotara Fertilizer Company	Yes
Slovakia	Agrofert Duslo, a.s.	Yes
Spain	Aragonesas Industrias y Energia S.A.	Yes
Spain	FERTIBERIA S.A.	Yes
Spain	FERTIBERIA S.A.	Yes
Switzerland	Lonza Ltd	Yes
Ukraine	CJSC "Severodonetsk Azot Association" I	Yes
Ukraine	CJSC "Severodonetsk Azot Association" II	Yes
Ukraine	JSC Azot/Cherkassy I	Yes
Ukraine	JSC Azot/Cherkassy II	Yes
Ukraine	JSC Azot/Cherkassy III	Yes
Ukraine	JSC Azot/Cherkassy IV	Yes
Ukraine	JSC Azot/Cherkassy V	Yes
Ukraine	JSC Azot/Cherkassy VI	Yes
Ukraine	JSC Dneproazot I	Yes
Ukraine	JSC Dneproazot II	Yes
Ukraine	JSC Rivneazot I	Yes

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Ukraine	JSC Rivneazot II	Yes
Ukraine	JSC Rivneazot III	Yes
Ukraine	JSC Stirol/Gorlovka I	Yes
Ukraine	JSC Stirol/Gorlovka II	Yes
Ukraine	JSC Stirol/Gorlovka III	Yes
Ukraine	Odessa Port Plant (OPZ) I	Yes
Ukraine	Odessa Port Plant (OPZ) II	Yes
United Kingdom	GrowHow UK Ltd.	Yes
United Kingdom	GrowHow UK Ltd.	Yes
United Kingdom	Yara UK Limited	Yes
US	Longview, WA — Pacific Coast Fertilizer	Yes
US	West Terre Haute, IN — Phibro	Yes
US	Kern County, CA – Grannus	Yes
US	Geneva, NE – Fortigen	Yes
US	Pasadena, TX — Pallas Nitrogen	Yes
US	Pollock, LA – TopChem	Yes
US	Monmouth, IL – Midwest BioEnergy	Yes
US	Gulf Coast, TX — Agrifos / Borealis	Yes
US	Vineyard, UT — Geneva Nitrogen	Yes
US	Wallaceburg, ON	Yes
US	Taylor County, FL — BioNitrogen	Yes
US	Hendry County, FL — BioNitrogen	Yes
US	Killona, LA – AM Agrigen	Yes
US	Belle Plaine, SK — FNA (ProjectN)	Yes
US	Freeport, TX — Yara/BASF	Yes
US	Victoria, TX — Invista	Yes
US	Rock Springs, WY — Simplot	Yes

US	Kemper County, MS — Southern Company	Yes
US	American Falls, ID — Magnida	Yes
US	Augusta, GA — PotashCorp	Yes
US	Battle River, AB — BioNitrogen	Yes
US	Beatrice, NE — Koch Industries	Yes
US	Beaumont, TX — OCI	Yes
US	Becancour, QB — IFFCO	Yes
US	Belle Plaine, SK — Yara	Yes
US	Beulah, ND — Dakota Gas	Yes
US	Borger, TX — Agrium	Yes
US	Brandon, MB — Koch Industries	Yes
US	Carseland, AB — Agrium	Yes
US	Casselton, ND — Agrebon	Yes
US	Cherokee, AL — LSB Industries	Yes
US	Cheyenne, WY — Dyno Nobel	Yes
US	Coffeyville, KS — CVR Partners	Yes
US	Courtright, ON — CF Industries	Yes
US	Creston, IA — Green Valley Chemical	Yes
US	Tuscola, IL — Cronus Chemical	Yes
US	Dodge City, KS — Koch Industries	Yes
US	Donaldsonville, LA — CF Industries	Yes
US	East Dubuque, IL — CVR Partners	Yes
US	El Dorado, AR — LSB Industries	Yes
US	Enid, OK — Koch Industries	Yes
US	Faustina, LA — Mosaic Company	Yes
US	Fort Dodge, IA — Koch Industries	Yes
US	Fort Saskatchewan, AB — Agrium	Yes

US	Fort Saskatchewan, AB — Sherritt	Yes
US	Geismar, LA — PotashCorp	Yes
US	Grand Forks, ND — Northern Plains Nitrogen	Yes
US	Greeneville, TN — US Nitrogen	Yes
US	Hardee, FL — BioNitrogen	Yes
US	Hopewell, VA — AdvanSix	Yes
US	Edgard, LA — EuroChem	Yes
US	Joffre, AB — Agrium	Yes
US	Kenai, AK — Agrium	Yes
US	Kern County, CA — HECA	Yes
US	Lima, OH — PotashCorp	Yes
US	Medicine Hat, AB — CF Industries	Yes
US	Midwest — Agrium	Yes
US	Morris, MN — University of Minnesota	Yes
US	Mt Vernon, IN — Midwest Fertilizer	Yes
US	Penwell, TX — TCEP	Yes
US	Pointe Coupee, LA — BioNitrogen	Yes
US	Port Neal, IA — CF Industries	Yes
US	Pryor, OK — LSB Industries	Yes
US	Redwater, AB — Agrium	Yes
US	Rockport, IN — Ohio Valley Resources	Yes
US	Spiritwood, ND — CHS	Yes
US	St Helens, OR — Dyno Nobel	Yes
US	Verdigris, OK — CF Industries	Yes
US	Waggaman, LA — Dyno Nobel	Yes
US	Wever, IA — OCI	Yes
US	Woodward, OK — CF Industries	Yes

US	Yazoo City, MS — CF Industries	Yes

Although some ammonia is produced as a byproduct from manufacturing other chemicals, 97 percent is produced by reacting hydrogen and nitrogen. Feedstocks and energy supplies are virtually always natural gas, light hydrocarbons, heavy residual oils, coke or coal.

Natural gas, where available, is most often used as the source of the hydrogen and as the fuel for economic and environmental reasons. This usage accounts for approximately 4 to 6 percent of the natural gas consumption in North America and Western Europe, and 40 percent in India. Natural gas typically represents 70 to 90 percent of the variable operating cost of ammonia production.

Technology is important. Today's dominant production technology is steam/methane reforming, to produce the required hydrogen, accounting for approximately 85 percent of the world's ammonia production. Coal-, coke- and residual oil-based ammonia production is also operational. In fact, 60 percent of China's ammonia production is coal-based. Although there are continual evolutions, the technologies are generally considered to be mature.

Questions:

2. **Description of common methods for suppling ammonia to fertilizer facilities across US and Europe,**
3. **Introduction of how the ammonia supply in the process of fertilizer industry across US and Europe,**

Answer:

The general trend to supply ammonia to the fertilizer industry as process (not to famers or other chemical companies end users) is to have an ammonia plant based on site, even a small-scale production.

In the United States chlorine and ammonia are classified as toxic inhalation hazards (TIH).

They are transported to end users by pipeline, barge, railcar and truck. Based on transport incidents in the past and general safety as well as security considerations transport restrictions and transport cost are an issue for many sites.

As is the case with chlorine more and more consumers of anhydrous ammonia evaluate smaller scale localized production to mitigate the transport risk and the related impact of transport cost.

In order to minimize the effect of economics of scale, technology options specifically suited for smaller production capacities have to be applied.

In the US Midwest numerous distribution centers, typically with storage capacities of 1,000 tons or larger receive their supply by pipeline, barge or railcars. Furthermore, there are many direct consumers of anhydrous ammonia like phosphate fertilizer plants, nitric acid / ammonium nitrate plants, nylon intermediate manufacturers or crop/food processing companies who import their ammonia feedstock by railcar or truck.

Typically, the last element in the supply chain is the transport by truck or tractor trailer to a storage at a farm or small scale industrial consumers. The most common road trailer used to transport anhydrous ammonia is the MC 331 high pressure tank. It has a capacity of 11,500 gallons (about 29 tons) and can also transport propane, butane, and LPG. The maximum operating pressure of the vessel is 300 PSI (20.7 bar).

In 2007 a volume of 3.9 million tons of ammonia was shipped by railcar in the United States.

In the United States about 12 million tons of ammonia are produced per year in 32 large scale plants with individual capacities of typically 1,000 – 2,000 tons per day. In addition, about 6 million tons of ammonia are imported per year into the United States.

The distribution network contains more than 800 retail distribution locations along with large-scale low-temperature storage facilities. There are ships, barges, semi-trailer tankers, rail cars and nurse tanks in use to distribute ammonia between the producers and consumers in places that do not have a pipeline nearby.

Storage facilities can be grouped in large scale atmospheric storage tanks of typically 10,000 tons or larger for production facilities, industrial consumers and large distribution centers and smaller scale storages of typically 100 – 1,000 ton in pressurized storage tanks (assumed as fixed storage tanks) at local distribution centers. Most farms have nurse tanks as 1000 gallon pressurized storage (3.785 m3, about 2.5 ton). Receiving facilities typically consume amounts from 40 tons per day (e.g. Farmer distribution centers or DeNOx applications) to 600 tons per day (e.g. phosphate fertilizer producers). Consumers of larger amounts of ammonia in many cases already have their own on-site production.

Question:

4. **Example for use of usage of iso-tankers as method to supply anhydrous ammonia in the fertilizer industry as a common mode of operation**

Answer:

To find a fertilizer manufacturer that use iso-tankers on daily basis to supply ammonia for its fertilizer production it is challenging due to the reasons described above.

However, through our network we manage to find a client in India (Deepak Fertilizer - DFPCL) who has extensive experience in receiving liquid ammonia in iso-tankers for daily production operation.

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One of our colleague from India was kind to answer the questions below that I ask in order to provide a better understanding of what means to use iso-tankers as method to supply anhydrous ammonia in the fertilizer industry as a common mode of operation:

1. **Please describe the path of imported anhydrous ammonia in Deepak:**
   a. **from which countries, local suppliers, etc.?**

   Ans. The import Ammonia is from Iran (Routed by sea & transported thru Cargoes)

   Yes, Local suppliers are also there: KRIBHCO (Gujarat- distance 280 km) & RCF (Thal – distance 100 km). Both companies are Ammonia & Urea Complex. The quantity of local supply is too small (6000 MT per month -maximum – This quantity is maximized based on ullage @ port tanks & K-1 tanks). This liquid NH_3 is directly unloaded in K-1 Complex with iso – tankers.

   b. **how many cargo ships per month?**

   Ans. Per month 2 cargoes are unloaded in port tank. Each cargo capacity is 10,500 MT to 16,500 MT. Normally we prefer 10,500 MT capacity, as this can be unloaded in single operation.

   c. **what is the tank capacity on the port terminal?**

   Ans. The Tank Capacity at port terminal is 15,000 MT. Normally we consider 1,500 MT NH_3 stock as dead stock (Non -pumpable NH_3). Hence, net capacity can be considered as 13,500 MT. This tank is associated with unloading bays, liquid NH_3 transfer pumps, NH_3 compressors for liquification of tank boil off & vapors from iso tankers during tanker filling, flare hearers & flare stack, Instrument Air compressor & DG sets for Emergency power supply.

   (Dan C. note: The ammonia is imported by ship, transfer into a storage tank in the port terminal and then, from the storage tank, is transfer to iso-tankers via unloading bays).

   d. **how many loading bays for iso-tankers on the port?**

   Ans. There are 5 loading bays for iso-tankers filling on port. From Tank liquid is transferred with help of pump with high head (20 Kg/cm2g) to unloading bays & there is provision of mass flow meters & XVs. After unloading of desired quantity XV on liquid line closes.

   e. **What is the distance between port terminal and Deepak site that iso-tankers must cover daily?**

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Ans. The distance between port terminal & Deepak site is ~40 km. The iso -tankers ~ 21 – 30 no's daily travels from port terminal to Deepak site.
The port tank terminal & jetty where the cargo births is having distance ~ 4-5km.Dedicated NH_3 line is layed from cargo port to Deepak port Tank farm.

f. How many iso-tankers per day incoming to Deepak site in Mumbai (overall not only from port)?
Ans. Presently 65 -70 no. iso tankers are unloaded in K-1 Complex. This is overall no. of tankers. The revamped facility is designed to handle 120 No. of tankers per day (1800 MTPD)

g. what is the capacity of each iso-tanker?

Ans. Each tanker is having capacity of carrying 14.5 – 14.8 MT of liquid NH_3. The Iso tanker volume is 30 M3. Approximately 20 % vapor space is considered in iso-tanker design.

We have made contract with transporter for trail of 19 MT liquid NH_3 capacity iso-tanker also. This trial was also successful & the proposal is under commercial negotiation for making all tankers of 19 MT capacity. This is mainly to reduce the turn-around time & cost of transport.

h. How many unloading bays are now available on Deepak site (after revamp)?

Ans. There are 12 No. of unloading bays available after revamp & additional 2 are planned. Hence, total no. of arms at K-1 facility will be 14 No, to handle 1800 MTPD liquid NH_3 Unloading.

2. Now, let's talk about quantities and ammonia overall balance:

a. What is the daily basis needed quantity for ammonia of Deepak site?

Ans. Deepak total daily requirement is ~ 1700 MTPD (All plants running on full capacity). Present average daily NH_3 consumption of Deepak is 1400 MTPD.

b. What type of and how many consumers of ammonia do you have on Deepak site (nitric acid, etc.)?

Ans. There are following Ammonia consumers:

- Fertilizer plants (ANP & NPK)
- Technical Grade Ammonium Nitrate (K- 1 & K-8 complex)
- Nitric Acid plants (Total 5 No. – Part quantity utilized for TAN & Fertilizer, rest for Conc. Nitric Acid production, which we sell in Marchand market.)

c. What is the current capacity of ammonia plant?

Ans. Present Ammonia plant is having capacity 380 TPD (Liquid Ammonia) + 10 TPD (Equivalent Ammonia H2).

d. The difference is cover by importing ammonia?

Ans. Yes, the differential Ammonia requirement i.e. ~ 1100 MTPD (present) or 1300 MTPD is covered by importing liquid ammonia from port (Iran) or from local vendors (KRIBHCO or RCF). The unloading facility is designed considering nil NH3 from plant. Hence, in case of any major break down or shutdown of Ammonia plant, the downstream will not be affected.

3. **What is the history behind the necessity of importing ammonia? Why you did not choose to build a bigger plant, same as everyone else? *(I remember you told me something about this).***

Ans. Brief History:

In year 1983 DFCL installed NH3 plant based on NG as Raw Material (Installed Capacity: 272 MTPD). There was no downstream plant (Ammonia consumer) in Deepak premises.

Initially there was only NH3 plant with 18000MT capacity (60 days inventory) & tanker filling station (Loading bays 6 No. with transfer pumps, Storage tank vapor handling compressors). Deepak use too export Ammonia to RCF trombay & other fertilizers plant.

In 90s Deepak installed Weak nitric acid plants & started consuming part quantity ammonia & was exporting rest ammonia.

Then onwards in phase manner downstream plants were commissioned (Weak Nitric acid, ANP, TAN, etc.)

In 1998 Deepak became net Importer of Ammonia & loading bays were converted to unloading bays.

To enhance the unloading rate of liquid Ammonia 1st refrigeration (Tanker liquid Ammonia cooling) system was commissioned in year 2005 & in past major revamps in ammonia plant to increase production capacity.

There on Deepak could able to manage total 1000 TPD ammonia requirement (350 TPD from plant & 750 TPD from unloading). In year 2010 Deepak commissioned the JNPT port terminal tank farm & started iso tankers movement from JNPT ports.

Why DFPCL choose to build new plant:

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The upcoming NH3 plant capacity is 1500 MTPD. There are many reasons for this project, are as follows:

- **Less dependency on RM:**
  Dependency on somebody for your major RM is sort of business risk. Changes in international relations / policies may hamper the business.
- **Energy Norms:**
  Present NH3 plant is of old technology & highly energy intensive (9 Gcal/MT). Whereas new NH3 plant is energy optimized with recent technologies.
- **Profitability:**
  If we could able to optimize the cost of Natural Gas in future, then bottom line of Deepak can improve much better with this 1500 MTPD NH3 volumes.
- We have commissioned new NPK plant in DFPCL taloja complex now. In future Deepak is going to be multi location company such as Dahej (Nitric acid complex), Paradeep (TAN, WNA complex), Panipat (Bensulf complex). In short again the captive consumption of Ammonia is going to increase.
  After commissioning of new Ammonia plant Deepak will shift existing Ammonia plant to paradeep site where ammonia requirement is 450 -500 TPD.

4. Using iso-tankers is part of your daily routine operation?

Ans. Yes. Using iso tankers is daily routine operation. Use of iso tankers is from year 1984 (previously it was for export as product & now it is for captive or import.)

Only thing is proper safety systems, SOPs, training & operation excellence over years lead DFPCL to handle it in safer manner & in bulk quantity too.

5. Do you have to modify the process to adapt to iso-tankers incoming daily?

No. In consumer plant process need not be changed. Only in tank farm area & unloading bay changes are required when you switch over to iso tankers. The details are mentioned in above questions.

Reference list:

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For any question please contact me.

Regards,

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