Livestock and Poultry Environmental Stewardship (LPES) curriculum

CAFO Fact Sheet series

Fact Sheet #7: Alternative Treatment Systems

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By John Sweeten, Texas A&M University; Ron Miner, Oregon State University; and Brent Auvermann, Texas A&M University

Overview of New EPA Regulations

The February 13, 2003 *Federal Register* revised the Environmental Protection Agency's (EPA's) "Part 412–Concentrated Animal Feeding Operations (CAFO) Point Source Category," which described the revised Effluent Limitations Guidelines (ELG) and New Source Performance Standards (NSPS) for concentrated animal feeding operations (CAFOs). The regulation applies to manure, litter, and/or process wastewater discharges resulting from CAFOs. Subpart C addresses dairy cows and cattle other than veal calves, which includes dairy operations and beef cattle feedlots. Subpart D addresses swine, poultry, and veal calves. Baseline ELGs in the revised rule prohibit discharge of process wastewaters except when rainfall events cause an overflow from a facility designed, constructed, and operated to contain (a) all manure, litter, and process wastewaters plus (b) the runoff from a 25-year recurrence interval, 24-hour duration rainfall event. The baseline ELGs fall into four categories:

1. Best practicable control technology (BPT) currently available
2. Best conventional pollutant control technology (BCT)
3. Best available technology (BAT) economically achievable
4. New source performance standards (NSPS)

In the revised CAFO rule, the definitions of BPT, BCT, and BAT are technologically identical in Subpart C (dairy and beef). Moreover, they are defined the same way (by reference) for Subpart D (swine, poultry, and veal). However, the NSPS for Subpart C are different than the NSPS for Subpart D in terms of the level of protection from rainfall events (25-yr, 24-hr vs. 100-yr, 24-hr storm events, for Subparts C and D, respectively) for new facilities.

Continued on next page

Voluntary Alternative Performance Standards (VAPS)

The revised CAFO rule provided an alternative avenue, *VAPS*, for managing manure, litter, and/or process wastewater discharges from CAFOs (Appendix A). The VAPS provisions are an alternative to the ELG in both Subpart C (i.e., dairy and beef cattle) and Subpart D (i.e., swine, poultry, and veal). In other words, the VAPS impose identical requirements on all CAFO operators who wish to move beyond the traditional, lagoon- or holding-pond-based waste management systems that have been the outcome of the no-discharge ELG for the last thirty years.

Alternative Technologies: A Discussion

In revising the guidelines for the management of manure, wastewater, and other process water generated by CAFOs, the EPA is acknowledging several important changes that have occurred since the first guidelines were released:

- A far greater proportion of livestock and poultry production in the United States takes place in CAFOs.
- CAFOs are generally larger and more technologically sophisticated than they were in 1970.
- Confined animal feeding is a more vertically integrated industry.
- Waste management technologies available to the CAFO industry have become more sophisticated and promise to become even more so in response to
  - Accelerated research and development.
  - Increasing emphasis on holistic or multi-media environmental protection.
  - Greater immediate pressure for air pollution control.
  - The need to achieve a higher level of production efficiency.

Traditional systems for management of CAFO runoff and manure have utilized earthen basins functioning as runoff control structures (RCS), manure storage basins, or anaerobic lagoons. These treatment or storage structures have made important contributions to cost-effective pollution control from livestock and poultry production facilities. As CAFO size and concentration have increased, however, it has become obvious that these earthen basins may not be adequate for all livestock and poultry enterprises. Among the situations in which they may have proven inadequate are those situations in which

- The number of animals confined produces nutrients (nitrogen and phosphorus) in amounts exceeding those needed for crop production on nearby agricultural land.
- Neighbors have been unwilling to tolerate odor and airborne pollutants associated with confined animal facilities, lagoons or RCS.

Traditional EPA and/or state regulatory approaches (i.e., the no-discharge approach) have encouraged most producers to use lagoons, earthen storage basins, (or RCS) and land application systems in lieu of adequate treatment to allow discharge (i.e., to public watercourses) or other uses. Moreover, the ELG/NSPS may have deterred innovators from developing scientifically sound technologies for potential markets because few incentives have existed for variance from the regulatory norm. The classical approach assumes that the increasing environmental stress associated with the increasing size of CAFOs can be met by increasing the size of storage (lagoons, storage basins, or RCS) and disposal (land application, evaporation, or other) systems. Moreover, in some locations the threat to groundwater may actually be *exacerbated* by adding lagoons, earthen storage basins, or RCS. In addition, traditional systems for effluent capture, storage, treatment, and land application may not adequately control emissions of odor, ammonia, hydrogen sulfide, volatile organic compounds, or other odorants.

Although lagoon/irrigation systems may work well for many CAFOs, particularly in the southern United States, they may not be the most appropriate technology for all CAFOs. For instance, very large CAFOs may have economies of scale that could facilitate the development and adoption of higher-order treatment/utilization technologies that may be more cost effective than acquiring additional land or excavating and managing larger lagoons or RCS. Systems with smaller footprints are technologically possible and may address additional environmental concerns along with surface water quality.

Research has demonstrated that there may be alternatives to the use of large open basins for the management of CAFO wastes. Among these are basin covers, which may be either permeable or impermeable for odor reduction. Another alternative is a series of processes that concentrate and harvest nitrogen (N) and phosphorus (P) for transport to an alternate watershed where they can be used as fertilizer. In other systems, the biogas resulting from the anaerobic digestion of animal manures is collected and used to generate electricity. These systems may produce enough energy to be marketed to the local utility company, offsetting the systems' capital and start-up costs.

Greater reliance on designed and managed soil/water/plant systems may offer advantages commensurate with those of the high-tech innovations.

The new ELGs for CAFOs set the stage for the development, evaluation and eventual adoption of innovative technologies that could offer a higher level of environmental protection and greater conservation of our finite energy resources. More attractive economic returns to CAFO operators have not yet been demonstrated for many promising concepts.

Encouraging Innovative Technologies

The VAPS may offer opportunities for protecting surface water, groundwater, and air quality. Research has shown that mechanical aeration or anaerobic digestion (mesophilic or thermophilic) for biogas production reduce odor, odorants, and ammonia emissions compared to traditional systems. Serial treatment processes consisting of ammonification/nitrification/denitrification (i.e., anaerobic/aerobic/anaerobic treatment) favor the conversion of manure N to dinitrogen gas rather than ammonia gas. Accurate emission estimates will be essential to evaluating air quality tradeoffs between treatment alternatives and the BAT/NSPS technology standards.

Recognizing shortcomings of present ELG baseline (no-discharge) technologies, EPA has indicated a long-term vision for CAFOs that will require continuing research to accelerate progress toward holistic environmental protection. The agency believes that the VAPS approach will encourage individual CAFO operators to develop and install new technologies and environmental management practices equal to or better than those required by baseline technology-based effluent guidelines (BPT, BCT, and BAT) and standards (NSPS). Furthermore, EPA recognizes and acknowledges that some CAFOs, land-grant universities (LGUs), state agencies, equipment vendors, and agricultural organizations are working to develop new technologies that reduce (a) nutrient and pathogen losses to surface water, (b) ammonia and other air emissions, and (c) groundwater contamination. These new technologies have the potential to match or surpass the level of environmental protection achieved by compliance with the baseline ELGs.

The new VAPS approach could allow producers to tailor systems to solve the most pressing problem or issue for a given site or production system. In some cases, such as water-limited regions, the most pressing challenge may be air quality considerations rather than water quality.

For severely land-limited systems, pollutant reduction sufficient for discharge (treat and release) could be a desired goal. This could encourage certain types of technologies such as anaerobic/aerobic/facultative treatment, followed by constructed wetlands for effluent polishing and storage. The treated effluent may become valuable for recycling as on-farm animal drinking water or for in-stream habitat maintenance.

Implementing the VAPS Approach

States will likely develop implementation guidelines. Individual states and CAFO operators with technology provided who are interested in pursuing the VAPS option will need to consider: (a) which performance standards can be legitimately substituted for current no-discharge requirements and (b) how tradeoffs are to be implemented. The preamble to the revised CAFO rule provides some general guidance.

To take advantage of the VAPS approach, producers and their technology providers will have to address numerous potential contaminants. According to the ELG supplemental information, "pollutants most commonly associated with animal waste include nutrients (including ammonia), organic matter, solids, pathogens, and odorous compounds. Animal waste can also be a source of salts and various trace elements (including metals), as well as pesticides, antibiotics, and hormones."

Under the VAPS provisions included in the final rule, large CAFO operators could demonstrate they can discharge process wastewater that has been treated by alternative technologies that achieve equivalent or better pollutant removal than the baseline effluent guidelines (EPA, 2003. Section IV c.2.e. (2), p. 7222) would achieve. These regulatory provisions are aimed at CAFO wastewater discharges to water bodies. EPA encourages CAFO operators participating in the VAPS program to consider the effect of environmental releases on water, soil, and air resources.

To demonstrate that an alternative control technology will achieve equivalent or better pollutant reductions than the baseline ELG, the CAFO operator must submit a technical analysis in which the pollutant reductions are calculated based on the site-specific, modeled performance of a system designed to comply with the baseline ELG. In general, the baseline system will be a lagoon, storage basin, and/or RCS designed, constructed, and operated to contain all manure, litter, and process wastewaters plus the runoff from a 25-year, 24-hour rainfall event (beef or dairy) or 100-year, 24-hour storm for new swine, poultry, or veal operations, as applicable. (EPA, 2003. Section IV. c.2.e. (2), p. 7222). For most chemical pollutants (e.g., N, P, BOD_5, metals), the mass of pollutants discharged will usually be the most appropriate measure for assessing treatment system performance and determining whether the alternative control technology will reduce those discharges. For some pollutants such as pathogens, however, pollutant mass may not be the most appropriate measure of pollutant reduction, and other measures will need to be used. Overall, the VAPS approach will probably require close monitoring.

One way to demonstrate performance equivalence consists of a two-step modeling process that estimates (a) the discharge of pollutants from a system meeting the baseline ELG and (b) the discharge of pollutants from the proposed alternative system. The first step is to run a computer simulation using site-specific or regional climate data and site-specific wastewater composition, thus estimating the pollutant discharge from a system meeting the baseline effluent guidelines (EPA, 2003. Section IV c.2.e. (2), p. 7222-7223). Such a model would estimate:

- The daily input to the storage system, including all process wastes, direct precipitation, and runoff.
- The daily output from the storage system, including evaporation, sludge removal, wastewater irrigation, and wastewater transfers to off-site users.

The simulation would then use the daily input and output estimates in a dynamic model of the lagoon/storage/RCS system to estimate (a) the likelihood or frequency and (b) the magnitude of overflows from the storage structures. The volume of discharge from each simulated overflow would then be multiplied by the concentrations of the pertinent pollutants to predict the mass of pollutants discharged in each overflow event. All of the simulated overflows would then be added up over a given time frame (e.g., 25 years) to estimate the total water-borne pollutant discharges associated with the baseline ELG for that facility. Similar estimates of pollutant loadings onto and from the associated land application areas likely would be needed to provide a complete picture.

If the hydrologic modeling in Step 1 were performed using climatic data from a period of unusually high precipitation, the overflow volume and the cumulative mass of pollutants discharged to receiving waters would be overestimated. Consequently, the baseline discharge threshold for that CAFO would be artificially high, resulting in an alternative performance standard that does not achieve the intent of the VAPS program. Conversely, if the modeling were performed using climatic data from a period of unusually low precipitation (e.g., drought periods), then the analysis would likely underestimate the baseline discharge thresholds. By requiring the CAFO operator to use precipitation data for a 25-year period, the technical analysis minimizes the bias introduced by short-term variations in climate patterns.

Step 2 of the process is to compute the rates at which pollutants will be discharged from the proposed, alternative technology. Those computations will originate either from engineering designs or from performance evaluations of similar systems in operation elsewhere. System designers, vendors, and/or operators will need to provide the data and document the assumptions, methods, and calculations used to generate those estimates. Then, those computed discharge rates will be summed up over a time interval equivalent to the one used in Step 1 as the basis of a comparison between the baseline system and the proposed, alternative technology.

In summary, CAFO operators pursuing the VAPS option will be required to meet the same discharge limitations implied by the baseline ELG. In many cases involving the advanced technologies currently available or in the final stages of development, the discharges will be continuous, low-level discharges analogous to industrial, point source releases. The ELG standard, in contrast, represents an intermittent, probability-based discharge associated with rainfall events exceeding the 25-year (or, for new swine, veal, and poultry CAFOs, the 100-year), 24-hour storm. To illustrate this type of analysis, EPA prepared an example evaluation using model farm characteristics. This example is available in the *Technical Development Document* and in Section 19.6.2 of the rulemaking record.

In general, EPA expects CAFO operators choosing the VAPS option to:

- Conduct a whole farm audit to quantify releases of significant water and air contaminants that occur at the point of generation.
- Estimate releases from the waste handling and management systems.
- Estimate discharges from land application and off-site transfer operations.

Documentation of the CAFO operators preferred technology alternative will need to include information that describes how the technology will improve environmental protection across all environmental media (e.g., air, water, and soil). At its discretion, the permitting authority can request supplemental information to document environmental improvement compared to the baseline ELG; the nature and extent of that additional information will be site- and technology-specific.

According to EPA (2003, Section IV. c.2.e. (4), p. 7223), CAFO operators interested in pursuing the VAPS should have a good compliance history: they should not be involved in enforcement actions under their existing permits at the time of VAPS application, and they should not have a history of significant noncompliance with state and/or federal regulations. They must prepare and submit an alternative program plan including but not limited to:

- The results of the hydrologic discharge analysis.
- The proposed method of storing, treating, and beneficially using manure, process wastewater, and contaminated runoff, including a performance-monitoring plan.
- The results demonstrating that these technologies and practices perform equivalent to or better than the baseline effluent guidelines.

This plan must be included with the CAFO operator's NPDES permit application or renewal, and when approved by the permitting authority, will be incorporated into the permit.

CAFO operators are expected to benefit from participation in the alternative standards approach through (a) greater operational flexibility, (b) improved neighbor relations, (c) reduced odor emissions, and potentially (d) lower net costs (EPA, 2003. Section IV. c.2.e. (4),

p. 7223). EPA is considering other incentives to encourage participation in the VAPS program under the assumption that its voluntary, flexible, performance-based aspects will harness market forces to achieve a steadily increasing level of environmental protection.

Toward Holistic Management Approaches

Discharges of environmental contaminants represent losses of energy, nutrients, or other potentially useful constituents out of the animal production system. Conversely, (a) retaining these constituents within the production system and (b) adding value to them through beneficial reuse or recycling may increase production efficiencies and improve environmental protection.

Environmental legislation is fragmented with respect to inherently interdependent media (air, surface water, soil, drinking water, groundwater). Current statutes and regulations cannot easily accommodate holistic thinking, an example of which is the environmental management systems (EMS) approach. To varying degrees, holistic management and technology systems, which appear to be the future of environmental protection in production agriculture, are in place in the industrial sector. However, some producers view EMS as a long, complicated, expensive, and redundant step beyond existing permit programs. Ironically, some environmental advocacy groups (EAGs) appear to view EMS as a loophole for substandard environmental protection.

The merit of the VAPS approach finds its roots in still another irony. Economies of scale are driving the trend to larger CAFOs and greater concentration of animals, in part to spread the ever-increasing cost of environmental protection over more and more animals produced. At the same time, EAGs tend to favor diffuse animal production over confinement systems. However, greater concentration might allow producers to capture the economies of scale that free resources to pay for the more expensive alternatives to lagoon systems.

Strategic Issues

EPA has opened the door to a more innovative CAFO industry through the VAPS approach. The concept remains somewhat general at present.

Land-grant universities (LGUs) allied with private and public technology and service providers can assist by taking a leadership role in strategic thinking that could set the course for implementing the VAPS program through some well-chosen successful examples. In that process, LGUs will need to bring producers, policy makers, and citizens' groups together to

- Ratify a common base of scientific understanding to undergird policy recommendations.
- Resolve the ironies of competing views of the same policy proposals, as in the debate over the adoption of EMS as alternatives to prescriptive permit programs.
- Harness competing agendas (e.g., economic, political, and environmental) in the context of a shared preference for performance-based standards.
- Exploit the synergy of parallel objectives where they exist among stakeholder groups.
- Develop, demonstrate, and transfer technology that will satisfy producers, environmental advocacy groups, and public concerns and increase the long-term sustainability of concentrated livestock and poultry production.

Several research and demonstration opportunities are suggested by the VAPS approach. These concepts include the following:

- Environmental nutrition methods and technologies to reduce nutrient excretion and/or dietary nutrient requirements.
- Designed grass filters, buffer strips, and infiltration areas, vegetative systems that reduce solids, nutrient and hydraulic loading.

- Air quality–process-based models (NRC 2003) to improve emissions estimates from covered lagoons, tanks, basins, open lots, and other sources.
- Constructed wetlands following pretreatment to polish pretreated wastewater to allow release to receiving water, seasonally or continually.
- Hybrid aerobic/anaerobic treatment systems–for shifting emissions to N gas rather than ammonia (Townsend et al. 2003) (see case example in Appendix A).
- Anaerobic digestion and thermal conversion–improving the cost effectiveness of systems to recover energy and reduce atmospheric emissions from agricultural biomass.
- By-product recovery schemes–N and P are harvestable and may have sufficient market value to justify costs.
- Industrial co-products–accelerating the recovery and value-added reuse of waste materials.

Summary

EPA's new CAFO rule provides for a performance-based, alternative technologies option to the no-discharge standard for CAFO waste management. The alternative technologies language in the new rule offers possibilities and potential flexibility for approving waste-management systems that discharge pollutants at a rate equivalent to or lower than nominal no-discharge systems.

The traditional no-discharge standard has been criticized for locking the CAFO industry into the earthen storage structure/land application paradigm. In recent years, environmental advocacy groups have intensified their call for the abolishment of lagoons and earthen storages. The VAPS language in the new CAFO rule provides the best policy opportunity yet to resolve that irony and adopt parallel objectives to the benefit of soil, water, and air resources, increasing the long-term sustainability of the animal feeding industry. ●

Appendix A
Case Example

The operators of a large, multi-site swine confinement facility in northern Missouri have designed and implemented a system to address concerns related to lagoon effluent runoff during irrigation on steeply-sloping clay soils, soil nitrogen loading, and emissions of odor ammonia and hydrogen sulfide (Townsend et al. 2003). The advanced nitrification and denitrification (AND) system was placed into operation in April 2002. It serves six production sites that each house 8,800 head of grow-finish pigs (52,800 head total). Nitrification and denitrification occurs at a centrally located wastewater treatment plant. The process description for the system is as follows:

- Existing anaerobic lagoons (6) for BOD_5, COD, TS, and VS reduction–placed permeable covers for odor reduction
- Lagoon effluent transfer (0.041-0.144 mgd) from each covered lagoon to the anoxic basin
- Mechanically mixed anoxic basin with 1.5-day hydraulic retention time (HRT) for nitrate and biochemical oxygen demand reduction
- Aeration basin (21-day HRT) designed for nitrification (w/recycle to anoxic basin)
- Settling basin with activated sludge return
- Biosolids storage basin
- Irrigation storage basin (180 day storage + 25-year, 24-hour rainfall)
- Irrigation to cropland or pasture land based on Phosphorus

First-year monitoring results have indicated reductions in odor (dilution to threshold) and in effluent N concentration (average 87% with sufficient aeration). Air emissions (odor, H_2S, NH_3, non-methane VOCs) as well as water quality monitoring data are being collected and will help optimize the system for the design of subsequent AND systems that can reduce air and water quality impacts. Consideration of economic benefits and costs will be a factor also.

Appendix B
Specific Regulatory *Language* Creating *the* VAPS *Approach*

Specific regulatory language follows:

Section 412.31 (a)(2). Voluntary alternative performance standards
Any CAFO subject to this subpart may request the Director to establish NPDES permit effluent limitations based upon site-specific alternative technologies to achieve a quantity of pollutants discharged from the production area equal to or less than the quantity of pollutants that would be discharged under the baseline performance standards as provided in paragraph (a)(1) of this section.

(i) Supporting information. In requesting site-specific effluent limitations to be included in the NPDES permit, the CAFO owner or operator must submit a supporting technical analysis and any other relevant information and data that would support such site-specific effluent limitations within the time frame provided by the Director. The supporting technical analysis must include calculation of the quantity of pollutants discharged on a mass basis where appropriate, based on a site-specific analysis of a system designed, constructed, operated, and maintained to contain all manure, litter, and process wastewater, including the runoff from a 25-year, 24-hour rainfall event. The technical analysis of the discharge of pollutants must include:

(A) All daily inputs to the storage system, including manure, litter, all process waste waters, direct precipitation, and runoff.

(B) All daily outputs from the storage system, including losses due to evaporation, sludge removal, and the removal of waste water for use on cropland at the CAFO or transport off site.

(C) A calculation determining the predicted median annual overflow volume based on a 25-year period of actual rainfall data applicable to the site.

(D) Site-specific pollutant data, including N, P, BOD, and TSS, for the CAFO from representative sampling and analysis of all sources of input to the storage system or other appropriate pollutant data.

(E) Predicted annual average discharge of pollutants, expressed where appropriate as a mass discharge on a daily basis (lbs/day), and calculated considering paragraphs (a)(2)(i)(A) through (a)(2)(i)(D) of this section.

(ii) The Director has the discretion to request additional information to supplement the supporting technical analysis, including inspection of the CAFO.

Section 412.31 (a)(3). The CAFO shall attain the limitations and requirements of this paragraph as of the date of permit coverage.

References

EPA. 2003. National Pollutant Discharge Elimination System Permit Regulation and Effluent Limitation Guidelines and Standards for Concentrated Animal Feeding Operations (CAFOs). Environmental Protection Agency; 40 CFR parts 9, 122, 123, and 412. *Federal Register*, 68(29): 7176-7264.

NAS. 2003. *Air Emissions from Animal Feeding Operations,* National Academy of Sciences, National Research Council, Washington, D.C.

Townsend, D.A., B.A. Paulson, and W.J. Wells, 2003. *Large Scale Nitrification/Denitrification of Swine Waste*. Paper prepared for Proceedings, 9th International Symposium on Animal, Agricultural, and Food Processing Wastes, Raleigh, NC, October.

Definition of Terms

BAT–Best available technology economically achievable

BCT–Best conventional pollutant control technology

BODS–Biochemical oxygen demand, 5-day

BPT–Best practicable control technology

CAFO–Concentrated animal feeding operation

COD–Chemical oxygen demand

EAG–Environmental action group

ELG–Effluent limitations guidelines

EMS–Environmental management system

LGU–Land-grant university

N–Nitrogen

NSPS–New source performance standards

P–Phosphorus

RCS–Runoff control structure

TS–Total solids

VAPS–Voluntary alternative performance standards

VS–Volatile solids

Authors

John Sweeten, Professor and Resident Director, Texas Agricultural Experiment Station-Amarillo, Texas A&M University, can be reached at j-sweeten@tamu.edu, and Ron Miner, Extension Water Quality Specialist, Oregon State University, can be reached at minerj@engr.orst.edu. Brent Auvermann, Associate Professor and Environmental Systems Engineering Specialist, Texas A&M University, can be reached at b-auvermann@tamu.edu.

Reviewers

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Environmental Regulations Related Resources
EPA CAFO Phone Line–202-564-0766

http://www.epa.gov/npdes/caforule/–To obtain copy of regulations

http://www.epa.gov/npdes/afo/statecontacts/–To obtain state environmental agency contacts

http://www.epa.gov/agriculture/animals.html/–To obtain compliance assistance information from EPA

http://cfpub.epa.gov/npdes/contacts.cfm?program_id=7&type=REGION/–To obtain EPA Region Animal Feeding Operation contacts

Land-Grant University Resources
The local contact for your land-grant university Cooperative Extension program is listed in the phone book under “Cooperative Extension” or “*(county name)* County Cooperative Extension.”

http://www.reeusda.gov/1700/statepartners/usa.htm/–To obtain state Cooperative Extension contacts

http://www.lpes.org/–To view the Livestock and Poultry Environmental Stewardship (LPES) curriculum resources

USDA Farm Bill Resources
To obtain more information about the Farm Bill 2002, see the USDA-NRCS website at http://www.nrcs.usda.gov/programs/farmbill/2002/. You can also contact your local USDA Service Center, listed in the phone book under “U.S. Department of Agriculture,” or your local conservation district.

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MWPS
MidWest Plan Service
122 Davidson Hall, ISU
Ames, IA 50011-3080

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