Agricultural Tractor Test Standards in America

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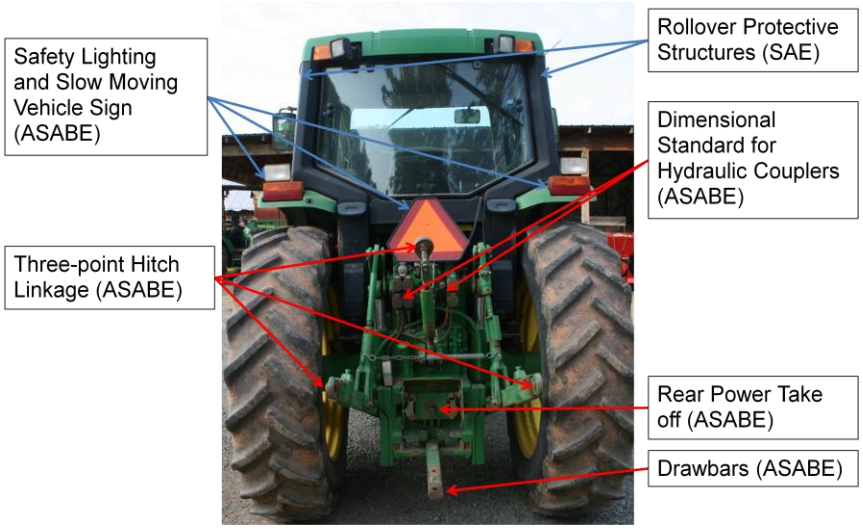
Introduction

The standards associated with tractors are much more complicated than one outside of the standard's profession might expect. Tractor standards include three basic types of standards: safety, performance and interoperability. There are seven different major Standard Development Organizations (SDOs) for the agricultural tractor industry: the Organization for Economic Co-operation and Development (OECD), International Organization for Standardization (ISO), International Electrotechnical Commission (IEC), Society of Automotive Engineers (SAE) International, American Society of Agricultural and Biological Engineers (ASABE), Association of Equipment Manufacturers – Equipment Manufacturers Institute (AEM-EMI), Nebraska Tractor Test Laboratories (NTTL). Other organizations involved in the process include the United States Department of Commerce, Nebraska Department of Agriculture division of Weights and Measures, Board of Regents University of Nebraska, Institute of Agricultural and Natural Resources, and Department of Biological Systems Engineering.

Why are agricultural standards unique? The initial SDO for the performance standards of tractors in the United States was the Nebraska Department of Agriculture and the University of Nebraska. Unlike most standards in the United States, which are driven by Non-Governmental Organizations, the initial tractor performance standards were developed by the Nebraska State Department of Agriculture. Tractor performance standards, like all standards, were born out of necessity. The industrial revolution and increase of larger population centers led to greater food demands which in turn required larger farms in the United States. With the boom of the internal combustion engine, many farmers began utilizing the mechanical advantages of tractors. One of the most important characteristics to consider when purchasing a tractor is the amount of work it can perform and how much energy or fuel is required. Thus the Nebraska Tractor Test was born. Later safety and interoperability standards were established.

Initially the performance standards for agricultural tractors were developed by a government organization, but today the standards are developed by many different organizations. They include non-government organizations, government organizations, accredited national, and accredited international standards organizations. The committees and sub-committees contain equipment manufacturers, industry professionals, academics, and government representatives. The scope of the OECD standards is international, although the main focus is on the United States, Europe and Asia. The standards are built around the following principles: transparency, openness, impartiality, consensus, and due process. The aforementioned principles ensure the standards do not create barriers to trade and improve the global market place.

The following research will provide more detail into the history and scope of the standards and Standard Development Organizations (SDOs) associated with agricultural tractors. The research paper will not attempt to list or define every standard associated with an agricultural tractor; Rather it will provide an overview with some specific illustrations and information on the standard development organizations that are unique to the field of agriculture. The ISO and IEC are some of the largest standard development organizations in the world and, therefore, have many standards related to agricultural tractors. The research will not provide detailed history and information on the ISO and IEC but will seek to provide information on the organizations which participate specifically on the agriculture committees. The standards are very interwoven and are constantly changing to meet the market needs. Below is a visual representation of some of the standards.



History of Tractor Test Standards

The newness of the internal combustion engine to the market place created many difficulties in the market place. The invention of the tractor was a means to capitalize on the internal combustion engine on the farm. Many of the earlier manufacturers were small local companies which made false advertising claims regarding their products. The use of tractors across the American farm would greatly increase during World War I due to the number of horses being used by the U.S. military. Many of the problems associated with early tractors were due to poor understanding of the loads and requirements on a tractor. Manufacturers were notorious for using automobile parts in the construction of tractors. This lack of engineering led to many dissatisfied customers across the American agricultural industry. The history of tractor test standards in the United States dates back to 1915 when farmers and manufacturers requested the federal government establish a universal rating system and testing facility. The inability to gain a consensus on which department, Commerce or Agriculture, would establish the standard led to the

proposal being abandoned.[1] Like many decisions in government, the inability to agree leads to no action and, therefore, the problem or issues goes unsolved until a private citizen takes action. Wilmont Crozier was that private citizen who took the initiative and forced changes for the public good.

Wilmot Crozier, a Nebraska farmer, decided in 1916 to trade in his horses for a tractor. Having been pleased with the operation of his Ford Model T automobile he decided to purchase a Model B Ford tractor made by the Ford Tractor Company of Minneapolis Minnesota for 350 dollars. Unfortunately, Mr. Crozier did not know that the Ford Tractor Company was in no way connected with the Ford Motor Company.[2] Since there was no universal standard for measuring the performance of tractors many companies advertised multiple measures of a tractors' performance, which included two different horsepower ratings and the number of turning plows a tractor was able to pull. The horsepower ratings were for the drawbar used to pull implements and the belt pulley was used to power stationary equipment. Most farmers were purchasing their first tractor; therefore, the number of horsepower was merely a number because the farmer had no reference for what a horsepower could accomplish in terms of work performed. If a farmer had previously worked with two horses it did not mean he only needed a two horse power tractor to accomplish the same amount of work. A horsepower is defined as "550 foot-pounds per second is approximately equivalent to 745.7 watts".[3] Also many times the horsepower claims of the manufacturer were inaccurate. By giving the farmer the number of plows the tractor could pull gave the farmer a quantifiable measurement of the tractor's ability to do work. However, there are many flaws with this unofficial standard, such as the number of plows a tractor pulls will vary greatly based on soil condition, soil type, depth of operation, and speed at which the implement is pulled. The Ford Model B purchased by Mr. Crozier was advertised as a 8-16 horsepower, two plow tractor. Once back in Nebraska with his tractor, Mr. Crozier discovered that it failed to perform to the manufacturers' claims. The following year he traded his 1916 model for a 1917 model which did not perform much better. The Ford Tractor Company would soon be out of business.[4] Mr. Crozier would then purchase a used Little

[1] Vossler, Bill. "Caveat Tractor, How the Nebraska Tractor Tests Saved the American Farmer." January/February 2007. GRIT Magazine. 28 June 2011 <http://www.grit.com/Tools/Caveat-Tractor.aspx>.

[2] Vossler, Bill. "Caveat Tractor, How the Nebraska Tractor Tests Saved the American Farmer." January/February 2007. GRIT Magazine. 28 June 2011 <http://www.grit.com/Tools/Caveat-Tractor.aspx>.

[3] Wikipedia, Horsepower. 27 June 2011. 29 June 2011 <http://en.wikipedia.org/wiki/Horsepower>.

[4] Wendel, C.H. "The Ford Tractor Company Minneapolis, Minnesota." September/October 1978. Gas Engine Magazine. 29 June 2011 <http://gasengine.farmcollector.com/Tractors/The-Ford-Tractor-Company-Minneapolis-Minnesota.aspx>.

Bull tractor also rated as a two plow tractor. It performed no better than the Ford Model B. Determined to purchase a tractor that would meet his needs Mr. Crozier purchased a Rumely OilPull rated as a three plow tractor. Later, he would say the Rumely OilPull could easily pull five plows.[5]

In 1915 Wilmont Crozier was elected to the Nebraska State legislature. Based on his miserable experience with tractors he would introduce a bill that would forever change the face of American tractor manufacturers. The bill stated:

- "A stock tractor of each model sold in the state be tested and approved by a board of three engineers under State University management
- Each company, dealer, or individual offering a tractor for sale in Nebraska shall have a permit
- A service station with a full supply of replacement parts for each model tractor shall be maintained."[6]

The first test was performed in 1920 on the Waterloo Boy Model N. In the first ten years the University Of Nebraska Department Of Agricultural Engineering would test 172 tractors with 65 of those being tested in the first year. "Within a few years, across the nation the entire tractor industry adopted the Nebraska Farm Tractor Tests as the gold standard."[7] The original purpose of the Nebraska Tractor Test was to ensure tractors were performing to the manufacturers' claims, specifically horsepower claims. The Nebraska Tractor Test would serve as the stand alone tractor performance test until the U.S. began partnering with the Organization for Economic Co-operation and Development (OECD) tractor codes in 1988.[8]

The OECD traces its routes to the Organization for European Economic Cooperation (OEEC). The OEEC was formed in the wake of World War II as part of the Marshal Plan implemented by the United States. OEEC was established in 1948 to reduce intra-European barriers to trade and promote coordination between European countries during reconstruction. OEEC began performance testing of tractors in 1959. The United States and Canada joined the OEEC in December 1960 by signing the OECD convention. The OECD was formally born in September 1961. There are 34 member countries of OECD today and six additional countries, either in negotiations with OECD or have close relations with

[5] Vossler, Bill. "Caveat Tractor, How the Nebraska Tractor Tests Saved the American Farmer." January/February 2007. GRIT Magazine. 28 June 2011 <http://www.grit.com/Tools/Caveat-Tractor.aspx>.

[6] Nebraska Tractor Test Laboratory, History. 29 June 2011 <http://tractortestlab.unl.edu/History.htm>.

[7] Vossler, Bill. "Caveat Tractor, How the Nebraska Tractor Tests Saved the American Farmer." January/February 2007. GRIT Magazine. 28 June 2011 <http://www.grit.com/Tools/Caveat-Tractor.aspx>.

[8] Hoy, Roger. "Statement by the Chair, OECD Tractor Codes." 2009. OECD Tractors. 29 June 2011 <http://www.oecd.org/dataoecd/28/3/46825144.pdf >.

OECD (40 total countries). The 40 countries, which in addition to European countries, include the United States, Japan, China, India, Brazil and Russia account for 80% of world trade.[9]

In 1988 the United States joined the OECD tractor codes. Many of the OECD tractor performance codes or standards were developed from the Nebraska Tractor Test Codes. The same year the state of Nebraska began issuing permits to manufacturers based on OECD tractor performance test from other nations. The United States representative to the OECD Tractor Codes is a Co-committee consisting of the Association of Equipment Manufacturers (AEM) and the NTTL. The reciprocity between OECD and Nebraska Tractor Test Codes greatly reduced the number of redundant test being performed, as the same tractors were being marketed to multiple countries. The synchronization of testing has influenced other areas outside performance including Roll Over Safety Protective Structure (ROPS) testing, noise at the operator ear test, and hydraulic power test.[10]

Scope of Standards

The agricultural equipment industry is a global industry. Globalization of the industry means that tractors and implements are routinely produced in one continent and distributed for sale on another. The International Organization for Standardization (ISO), International Electrotechnical Commission (IEC), and the SAE International are international organizations which produce global standards. ISO is the largest SDO in the world and has 162 member nations.[11] These organizations produce standards for an extremely wide array of products. Conversely, the OECD tractor codes are specifically focused on the agricultural tractors and forestry equipment. The OECD tractor codes are officially accepted by 28 countries all over the world.[12] The ABSE and NTTL are national standard development organizations which in many cases serve on the committees of the international SDOs.

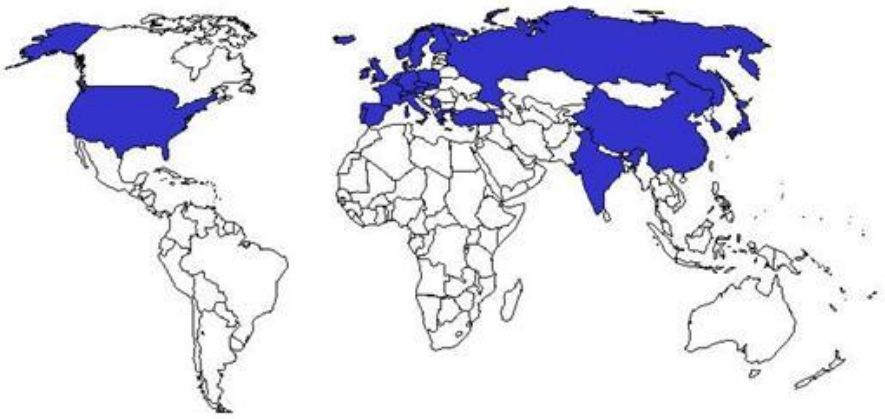
[9] OECD, History. 29 June 2011 <http://www.oecd.org/pages/0,3417,en_36734052_36761863_1_1_1_1_1,00.html>.

[10] Hoy, Roger. "Statement by the Chair, OECD Tractor Codes." 2009. OECD Tractors. 29 June 2011 <http://www.oecd.org/dataoecd/28/3/46825144.pdf >.

[11] ISO. About ISO. 11 July 2011 <http://www.iso.org/iso/about.htm>.

[12] OECD. "Participating Countries, National Designated Authorities and Testing Stations in the OECD Tractor Codes." OECD Trade and Agricultural Directorate. 12 July 2011 <http://www.oecd.org/document/48/0,3343,en_2649_33905_1814320_1_1_1_1,00.html>.

Participating Countries, National Designated Authorities and Testing Stations in the OECD Tractor Codes



[13]

According to the OECD the standard code for the performance of tractors applies to "self propelled wheeled tractors, having at least two axels, or tracks designed, to carry out the following operations, primarily for agricultural and forestry purposes:

- To pull trailers;
- To carry, pull or propel agricultural and forestry tools or machinery and, where necessary, supply power to operate them with the tractor in motion or stationary."[14]

The OECD definition includes all sizes and types of machinery that satisfy two specific criteria: self propelled and provides a motive force for other agricultural equipment. These are important because they eliminate two other large categories of equipment: all stationary engines and power units and all self propelled harvesters and windrowers. The Nebraska Department of Agriculture defines a tractor as "…an agricultural tractor of forty or more horsepower which is a traction machine designed and advertised primarily to supply power to agricultural implements and farmstead equipment. An agricultural tractor propels itself and provides a force in the direction of travel to enable attached soil-engaging and other implements to perform their intended function."[15] By adding the minimum horsepower requirement to the tractor definition, the Nebraska Department of Agriculture has eliminated many small tractors which are considered to be consumer or homeowner products.

[13] OECD. "Participating Countries, National Designated Authorities and Testing Stations in the OECD Tractor Codes." OECD Trade and Agricultural Directorate. 12 July 2011 <http://www.oecd.org/document/48/0,3343,en_2649_33905_1814320_1_1_1_1,00.html>.

[14] OECD. "OECD Standard Code for the Official Testing of Agricultural and Forestry Tractor Perfomance." Februrary 2011. OECD Code 2. Pp 4. 13 July 2011 <http://www.oecd.org/dataoecd/60/39/44520790.pdf>.

[15] State of Nebraska. "Tractor Testing Statutes." November 1995. Nebraska Department of Agriculture Laws & Regulations. 1 July 2011 <http://www.agr.state.ne.us/regulate/wam/actw.htm>.

Standards Development Organizations

Organization for Economic Co-operation and Development (OECD)

There are 28 different countries that participate in the OECD Tractor codes. Twenty four of the countries are official members of OECD. The other four countries which participate in the Tractor Codes are China, India, the Russian Federation, and Serbia. Participation in the tractor codes provides a common set of test procedures for tractors in three areas: performance, driver safety, and noise measurement. Each country has accredited testing stations which follow the OECD Tractor Codes when testing tractors. The test results are then submitted to OECD for approval. [16] Approved test results are public via the OECD website.

The OECD has certified the performance test of over 2750 tractors worldwide in the last 52 years. Almost 11,000 tractors have been evaluated for the noise at the operator's station. The OECD tractor codes are viable standards to remove trade barriers specifically between the United States and Europe. A main principle of the OECD codes is "one-tractor one-description one-test"[17]. This means that once a tractor is tested the results are accepted globally by nations participating in the OECD Tractor Codes. The OECD tractor codes "simplify existing international trade procedures, to establish specifications and basic performance criteria and to ensure a minimum quality for the traded material."[18] The OECD tractor codes contain the essential qualities to maintain a good standard: Openness, Transparency, and Consensus. There are nine active codes published by OECD.

- **Code 1:** *repealed*
- **Code 2:** the performance of tractors
- **Code 3:** the strength of protective structures for standard tractors (Dynamic Test)
- **Code 4:** the strength of protective structures for standard tractors (Static Test)
- **Code 5:** noise measurements at the driver's position[s]
- **Code 6:** the strength of the front-mounted roll-over protective structures on narrow-tract wheeled agricultural and forestry tractors

[16] OECD, About OECD Tractor Codes. 30 June 2011 <http://www.oecd.org/document/55/0,3746,en_2649_33905_39582839_1_1_1_37401,00.html>.

[17] OECD. "OECD, Standard Codes for the Official Testing of Agricultural and Forestry Trators." February 2011. OECD General Text. Pp 4. 15 June 2011 <http://www.oecd.org/dataoecd/61/21/44525381.pdf>.

[18] OECD. "OECD, Standard Codes for the Official Testing of Agricultural and Forestry Trators." February 2011. OECD General Text. Pp 4. 15 June 2011 <http://www.oecd.org/dataoecd/61/21/44525381.pdf>.

- **Code 7:** the strength of rear-mounted roll-over protective structures on narrow-track wheeled agricultural and forestry tractors
- **Code 8:** the strength of protective structures on tracklaying tractors
- **Code 9:** the strength of protective structures for telehandlers
- **Code 10:** the strength of falling object protective structures for agricultural and forestry tractors [19]

OECD: Openness

The OECD tractor codes illustrate openness. Any country that is part of the United Nations Organization is eligible to join the codes after meeting the requirements. These requirements include a written application, inspection of the test facilities, and a review of legislative regulations concerning the international trade of tractors. Once meeting the requirements the Committee for Agriculture of the OECD will recommend to the Council (OECD) admittance of the country to the OECD Tractor Codes. The fee for each nation joining the tractor codes is 3000 Euros.[20]

OECD: Transparency

The OECD Tractor Codes are transparent because they are published for the public. A list of National Designated Authorities (example ASABE) and testing stations or Co-coordinating Centers (example AEM and NTTL) with contact information are listed in the Tractor Codes (Appendix A). OECD has approved test laboratories which are sanctioned to perform the test in accordance with the OECD codes. Once the test is performed the results are then submitted to OECD for validation and certification.

OECD: Consensus, Due Process, and Impartiality

The OECD tractor codes illustrate consensus by establishing an annual meeting and providing a procedure and means for redress. Each year the codes are reviewed at an annual meeting of the National Designated Authorities for tractor codes. Each member country is required to have a National Designated authority present at the meeting. The order of officers for the annual meeting is determined alphabetically by nation for both OECD member nations and non OECD member nations. The officers include a Chairman and two Vice-chairman. The purpose of the meeting is to review the operation and development of the tractor codes and produce a report for the OECD council. The OECD Committee for

[19] OECD. "OECD, Standard Codes for the Official Testing of Agricultural and Forestry Trators." February 2011. OECD General Text. Pp 6. 15 June 2011 <http://www.oecd.org/dataoecd/61/21/44525381.pdf>.

[20] OECD. "OECD, Standard Codes for the Official Testing of Agricultural and Forestry Trators." February 2011. OECD General Text. Pp 13. 15 June 2011 <http://www.oecd.org/dataoecd/61/21/44525381.pdf>.

Agriculture must first review and approve the report before submission to the OECD Council.[21] There are also bi-annual Test Engineer conferences held around the world: "The Test Engineers Conferences permit a correct and coherent interpretation of testing procedures and prepare their updating. Their primary purpose is the observation, review and discussion of testing practices by Test Engineers."[22]

There is an Advisory Group which consists of the officers from the annual meeting and the Co-coordinating Centers or test laboratory which submitted the test in question. Any National Designated Authority may question the denied approval of a test. The Advisory Group is then convened and seeks to resolve the issue providing a written statement to the National Designated Authority within two weeks. If the submitting National Designated Authority is still not satisfied the issue is tabled and is re-addressed at the following annual meeting.[23]

OECD: Effectiveness and Performance Based

The effectiveness of the OECD tractor codes is illustrated by the number of nations which participate. The inclusion of nations outside of OECD member nations (example: Peoples Republic of China, India, and the Russian Federation) demonstrate the OECD tractor codes global effectiveness. The tractor codes publish horsepower, fuel efficiency, and hydraulic performance reports which are available to the public (Appendix B).

How do the ISO standards and OECD tractor codes differ?

OECD codes provide the centralized testing methodology for a complete unit, hence the statement one-tractor one-test. Conversely the ISO standards focus on standardization of individual pieces or components of the complete unit. They provide processes for manufacturing, measuring or testing on specific parts of the completed unit.[24] For example, OECD code 2 performance test defines the method for conducting hydraulic lift test which references ISO 730-1:1994 (Agricultural wheeled tractors -- Rear-mounted three-point linkage -- Categories 1N, 1, 2N, 2, 3N, 3, 4N and 4) for the specific

[21] OECD. "OECD, Standard Codes for the Official Testing of Agricultural and Forestry Trators." February 2011. OECD General Text. Pp 14. 15 June 2011 <http://www.oecd.org/dataoecd/61/21/44525381.pdf>.

[22]OECD. OECD, Tractors. 30 June 2011 http://www.oecd.org/document/35/0,3343,en_2649_33905_39577123_1_1_1_37401,00.html

[23] OECD. "OECD, Standard Codes for the Official Testing of Agricultural and Forestry Trators." February 2011. OECD General Text. Pp 15. 15 June 2011 <http://www.oecd.org/dataoecd/61/21/44525381.pdf>.

[24] OECD. "OECD, Standard Codes for the Official Testing of Agricultural and Forestry Trators." February 2011. OECD General Text. Pp 4. 15 June 2011 <http://www.oecd.org/dataoecd/61/21/44525381.pdf>.

adjustments of the linkage.[25] The OECD codes rely on the standardization of components provided by ISO. It would be impossible to conduct a standard performance test on tractors from different manufacturers if the connections for each manufacture were different. The centralized international approval for testing of compete units provide the manufacturers and consumers with a standard of comparison for overall unit performance.[26]

International Organization for Standardization (ISO)

ISO is the world's largest standards organization with 162 member countries. They serve as one of the governing bodies for agricultural tractor standards. The U.S representative for most ISO agricultural committees is ASABE.[27] There are 62 ISO standards specifically for agricultural tractors.[28] Many of the ISO standards are for the interoperability of tractors and equipment. Unlike an automobile which is generally operated as a single unit, a tractor is ineffective if it cannot be coupled with an implement. The connections include the drawbar, integral or three point hitch, power take off, hydraulic couplings, and electrical connections. ISO has standards for most every component of tractors.

American Society of Agricultural and Biological Engineers (ASABE)

ASABE is an organization of engineers and other professionals in all fields related to agriculture. Originating in 1907, in Michigan, ASABE has grown to over 9000 members in over 100 countries.[29] The organization is focused on the education and advancement of engineering in agriculture. They also facilitate the exchange of technical information and standards. ASABE is divided into main four councils: membership, meetings, publications, and standards, and eleven technical specialty areas.[30] Membership is open to anyone interested in the field of agriculture and biological engineering.

ASABE is an American National Standards Institute accredited SDO. ASABE committees serve as the U.S. Technical Advisory Groups (US TAGS) for ISO. The committees consist of individual

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[25] OECD. "OECD Standard Code for the Official Testing of Agricultural and Forestry Tractor Perfomance." Februrary 2011. OECD Code 2. Pp 21. 13 July 2011 <http://www.oecd.org/dataoecd/60/39/44520790.pdf>.

[26] OECD. "OECD, Standard Codes for the Official Testing of Agricultural and Forestry Trators." February 2011. OECD General Text. Pp 4. 15 June 2011 <http://www.oecd.org/dataoecd/61/21/44525381.pdf>.

[27] Tsunemori, Travis. ASABE Technical Services Support Engineer Chad Ingle. 14 July 2011.

[28] ISO. ISO 65.060.10: Agricultural tractors and trailed vehicles. 11 July 2011 <http://www.iso.org/iso/iso_catalogue/catalogue_ics/catalogue_ics_browse.htm?ICS1=65&ICS2=060&ICS3=10>.

[29] ASABE. About ASABE. 14 July 2011 <http://www.asabe.org/about.html>.

[30] ASABE. About ASABE. 14 July 2011 <http://www.asabe.org/about.html>.

professionals. Companies do not have corporate representation on committees. Although employees of a large corporation may serve on the committees they must vote as individuals. ASABE maintains the right to allow many people to join a committee but they limit the number of voting members. Specifically they limit the number of voting members from any one single company or organization. This is required to maintain a fair and balanced standard.[31]

SAE International

In the past SAE International had a dedicated technical committee for agricultural tractors known as the Agricultural Tractor Standards Committee (ATSC). The ATCC was part of the Construction, Agriculture, and Off-Road Machinery (ConAg) Council. The ATSC is a joint committee with ASABE and AEM. Recently, most of the ATSC functions have been transferred to the ASABE with exception of the Roll Over Protective Structures standards.[32] ASTC also continues to play major roll in off-road emissions standards. The ATSC includes equipment manufacturers, suppliers, consulting firms, government organizations and others from the agricultural industry.[33] ASABE standards on tractors are from the tractor hitch back while the SAE standards cover everything forward of the hitch including the engine and power train components.[34]

AEM

AEM is the association of equipment manufacturers. They are a trade organization which participates with ASABE and SAE. They serve as the manufacturers' representation on many of the committees and U.S. TAGs.[35] AEM is also very important because they financially support organizations such as ASABE. Their support ensures ASABE and other organizations have the required resources to maintain an active presence in national, regional, and international standards. AEM is also part of the

[31] Tsunemori, Travis. ASABE Technical Services Support Engineer Chad Ingle. 14 July 2011.

[32] Wright, Jana. SAE International Sr. Standards Specialist Chad Ingle. 26 July 2011.

[33] SAE. SAE Technical Committee Agricultural Tractor Standards Committee (ATSC). 12 July 2011 <http://www.sae.org/servlets/works/committeeHome.do?comtID=TECATSC>.

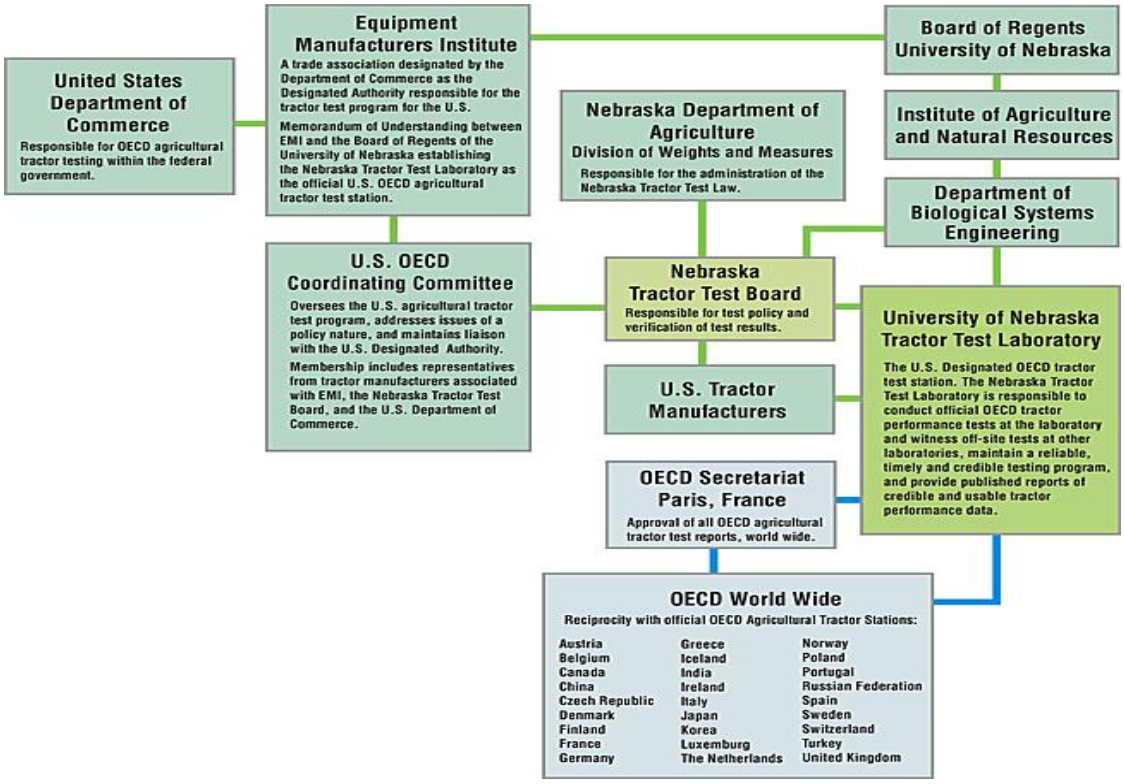
[34] Tsunemori, Travis. ASABE Technical Services Support Engineer Chad Ingle. 14 July 2011.

[35] AEM, About. 1 July 2011 <http://www.aem.org/About/>.

U.S. OECD Co-coordinating Committee which also includes representatives from the NTTL and U.S. department of Commerce.[36]

Nebraska Tractor Test Laboratory (NTTL)

The NTTL functions under the direction of two different organizations in the State of Nebraska. The first is the University Of Nebraska Department Of Biological System Engineering and the second is the Nebraska Department of Agriculture, Division of Weights and Measure. Together they form the Nebraska Tractor Test Board who is responsible for the test policy and verification of results. The NTTL is operated by the University of Nebraska Tractor Test Laboratory. The NTTL serves as the officially designated OECD testing station in the United States. According to OECD Tractor codes, all tractors must be tested in the same country they are built. After the report is compiled they are submitted to the OECD for final approval. Once approved by the OECD has approved the report it must be accepted by all countries participating in the OECD Tractor Codes.[37] Below is the organization of the NTTL.



[38]

[36] AEM Groups - AEM Technical Groups, OECD U.S. Coordinating Committee (OECD). 29 June 2011 <http://www.aem.org/Groups/Groups/Group.asp?G=93>.

[37] Nebraksa Tractor Test Laboratory. 19 July 2011 <http://tractortestlab.unl.edu/index.htm>.

[38] Nebraska Tractor Test Laboratory, Organization. 30 June 2011 <http://tractortestlab.unl.edu/organization.htm>.

The Nebraska Tractor Test Board of Engineers was established by the Nebraska Tractor Test Act. The Board of Engineers is responsible for rules and regulations for official tractor testing in accordance with SAE, ASABE, and OECD codes. They are also responsible for interpreting the Nebraska Tractor Test Laws. The Nebraska Tractor Test Board has the authority and responsibility to develop University of Nebraska Test Board Action to aid in carrying out the Tractor Test Law.[39] The Actions of the Board are developed to ensure all testing procedures at the NTTL meet the requirements of the SAE, ASABE, and OECD. When additional procedures are required by the Nebraska Tractor Test Act or OECD codes, the Board of Engineers, along with input from manufacturers and other interested parties develop the new Actions.[40] To simplify, the Boards Actions are standards which ensure the testing procedures meet the requirement of other statues (example: Nebraska Law and OECD Codes).

The NTTL TEST: There are 23 current Board Actions.

Action 5: Recommendations for Supplemental Permits

Action 6: Maximum Drawbar Power Runs

Action 8: Maximum Travel Speed for Drawbar Fuel Runs

Action 11: Environmental Conditions for Drawbar Testing

Action 12: Sound Level Retest

Action 16: Supplementary Sales Permit Based upon a Tractor Test of another Company

Action 17: Withdrawal of a Tractor from a Nebraska Tractor Test

Action 18: Meeting Advertised Claims

Action 19: Performance within an Operating Speed Range

Action 20: Fuel Flow Specifications and Fuel Temperature

Action 22: Certification of New Tire Tread Bar Height

Action 23: Procedures when Tests are Rescheduled or Canceled

Action 24: Agricultural Tractor Definition

Action 25: Sound Tests

Action 27: Tractor Model

Action 28: Tractors Requiring a Limited Test

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[39] Nebraska Tractor Test Laboratory, Board Actions. 19 July 2011 <http://tractortestlab.unl.edu/board.htm>.

[40] Nebraska Tractor Test Laboratory, Board Actions. 19 July 2011 <http://tractortestlab.unl.edu/board.htm>.

Action 29: Supplemental Sales Permits Linked to Action 27

Action 30: Timing for Use of Data and Results from Tractor Tests

Action 31: Required Tractor Power Specifications

Action 32: Determination of Fuel Temperature Used During Testing

Action 33: Advertising Changes Allowed After Tests

Action 34: SCR and DPF Tests for Sales Permits

Action 35: Required Three-point Lift Tests [41]

Twelve of the Board Actions have been rescinded entirely or replaced by newer Actions. While all of the Actions are important, I will discuss several of the Actions in more detail. First I will provide a simplified overview of the test. Each tractor performance test consists of six basic measurements: PTO horsepower, drawbar horsepower, fuel efficiency, sound level at the operator's station, three point hitch lift capacity, and hydraulic flow capacity for power beyond the tractor. The tests range in length, the longest test required are the fuel efficiency test which are two hours. Each test requires a fifty dollar permit fee.[42] There are two test seasons, spring and fall, with up to forty tractors tested each year.[43]

Action 27, Tractor Model, list the specifications that manufacturers must provide for each model they distribute for sale. Board Action 27 prescribes the information required by Nebraska law to obtain a permit with regard to tractor model. The specifications required for each model are, rated engine speed, maximum power at one of the three locations: drawbar, Power Take Off (PTO), or engine, engine displacement, engine manufacture, consumable fluid, and chassis type.[44] The identifications of specific models are a very important part of a manufacturers' marketing process. Board Action 27 is the baseline for identifying a tractor model for test and for the market.[45] Board Action 31, Required Tractor Specifications, requires the manufacturer to submit general advertising literature containing performance

[41] Nebraska Tractor Test Laboratory, Board Actions. 19 July 2011 <http://tractortestlab.unl.edu/board.htm>.

[42] State of Nebraska. "Tractor Testing Statutes." November 1995. Nebraska Department of Agriculture Laws & Regulations. 1 July 2011 <http://www.agr.state.ne.us/regulate/wam/actw.htm>.

[43] Hoy, Roger M. "Director's Comments." Spring 2010. Nebraska Tractor Test Laboratory. 22 July 2011 <http://tractortestlab.unl.edu/Director2.htm>.

[44] "Board Action No. 27." 14 October 2010. Nebraska Tractor Test Laboratory, Board Actions. 21 July 2011 <Nebraska Tractor Test Laboratory, Board Actions>.

[45] "Board Action No. 27." 14 October 2010. Nebraska Tractor Test Laboratory, Board Actions. 21 July 2011 <Nebraska Tractor Test Laboratory, Board Actions>.

data,[46] is very similar to Action 27. The main difference is that Action 27 seeks to identify models, whereas Action 31 requires the manufactures' official performance literature. The goal of the NTTL is to validate the manufacturers' performance claims as a method to ensure fairness industry wide; Therefore, both model and power specifications are very important.[47]

Maximum Drawbar Power Runs testing requirements are described in Board Action 6. The unbiased test to determine the amount of work a tractor can perform is the reason the test originally began in 1928. "The maximum drawbar power of a tractor shall be determined as follows:

1. Tractors with geared transmissions shall be operated:
    a. In all gears in which neither a travel reduction (slip) of 15% nor a travel speed of 8 mph is exceeded while maintaining rated engine speed.
    b. In that gear immediately slower than the slowest run (a above) with the load adjusted to produce a slip approaching 15% (engine speed is likely to be higher than rates speed in this maximum pull run), and
    c. In a gear providing a speed over 8 mph and not exceeding 10 mph while maintaining rated engine speed…"[48]

While the rules may seem very straight forward a good deal of effort goes into determining the speed and set up of the tractor to obtain the maximum pull. Tractors are tested in multiple gears at different engine speeds and in multiple configurations. For an example OECD approved test report see Appendix C (Nebraska Tractor Test No. 1801, John Deere 8520, dated 23 July 2002). At the time of the test the 8520 was the largest Row Crop tractor manufactured by John Deere, the following examples are from Test No. 1801.[49] Proper ballasting and selection of engine speed can significantly affect the tractor's performance. The 8520 had an unballested weight of 23,800 pounds while almost 10,000 additional pounds were added to achieve a weight of 33,580 for the ballasted portion of the test. This effectively increased the weight by nearly fifty percent. Also of note is the different engine speeds, both rated and maximum power, at which the tractor was tested. The rated speed refers to the engine revolutions per minute (rpm)

[46] "Board Action No. 31." 11 November 2010. Nebraska Tractor Test Laboratory, Board Actions. 14 July 2011 <http://tractortestlab.unl.edu/board/ttl_action31.pdf>.
[47] "Board Action No. 31." 11 November 2010. Nebraska Tractor Test Laboratory, Board Actions. 14 July 2011 <http://tractortestlab.unl.edu/board/ttl_action31.pdf>.

[48] "Board Action No. 6." 17 August 1998. Nebraska Tractor Test Laboratory, Board Actions. 21 July 2011 <http://tractortestlab.unl.edu/board/ttl_action6.pdf>.

[49] Sampson, Brent T. "NEBRASKA OECD TRACTOR TEST 1801–SUMMARY 367." 23 July 2002. Nebraska Tractor Test Laboratory, Test Reports. 21 July 2011 <http://tractortestlab.unl.edu/Deere/8520.pdf>.

which correlate to a PTO speed of 1000 (+/- 10 rpm). At the rated engine speed 2200 rpm the 8520 produced 225.13 horsepower. The maximum horsepower of 256.36, which was obtained at 2000 rpm is an increase of ten percent over the maximum horsepower at rated speed. This is important because a farmer will not likely use a tractor such as the 8520 for PTO operations at rated engine speed, but a farmer is more likely to use it to pull drawn implements. Thus the most important rating is the maximum horsepower rating.

Board Action 18, Meeting Advertised Claims, provides guidelines which the NTTL uses to make recommendations on whether or not a permit to allow sales should be issued by the State of Nebraska.[50] There are three different categories which the data from NTTL test must equal to or great than the manufacturers claims: PTO performance (maximum power and fuel consumption), drawbar performance (maximum power), and sound level at the operator's stations.[51]

Lastly, Board Action 30 is Timing for Use of Data and Results. Action 30 is critical because it defines the beginning and end of the official test and when from NTTL may be used by the manufacturer for advertising.[52] Company officials are responsible for all preparatory and warm actions for each tractor. Once the manufacturer is ready to begin the official test, they notify the NTTL who records all of the information discussed in early sections and the number of usage hours on the machine. From that point forward any changes made by the company representatives are recorded in the official test record.[53] No company wants to have in the official test record that manufacturer adjustments were required to complete the test; it is the equivalent of a new car breaking down on a test drive. Once the tests are complete and the test engineers and the manufacturer are satisfied with results both parties sign the End of Official Test section on the Official Test Form.[54] This makes the official end to the test and the next step for the NTTL Board of Engineers to certify the results. A key point is that the manufacturer must sign off that they are satisfied with the results even though the NTTL performs the test as an unbiased

[50] "Board Action No. 18." 17 August 1998. Nebraska Tractor Test Laboratory, Board Actions. 21 July 2011 <http://tractortestlab.unl.edu/board/ttl_action18.pdf>.

[51] "Board Action No. 18." 17 August 1998. Nebraska Tractor Test Laboratory, Board Actions. 21 July 2011 <http://tractortestlab.unl.edu/board/ttl_action18.pdf>.

[52] "Board Action No. 30." 8 March 2007. Nebraska Tractor Test Laboratory, Board Actions. 18 July 2008 <http://tractortestlab.unl.edu/board/ttl_action30.pdf>.

[53] "Board Action No. 30." 8 March 2007. Nebraska Tractor Test Laboratory, Board Actions. 18 July 2008 <http://tractortestlab.unl.edu/board/ttl_action30.pdf>.

[54] "Board Action No. 30." 8 March 2007. Nebraska Tractor Test Laboratory, Board Actions. 18 July 2008 <http://tractortestlab.unl.edu/board/ttl_action30.pdf>.

organization. This is done for multiple reasons. One, the implications of tractor not meeting advertised claims would be a significant marketing blow and not receiving a permit allowing the sell of the tractor in Nebraska. Secondly, having the most horsepower or best fuel efficiency are incredible marketing tools. The test results may not be used by the manufacturer for advertising until the entire test is complete. If the results are used before they have been certified by the NTTL Board of Engineers the manufacture cannot state the test report number.[55]

The Importance of an Unbiased Test

The NTTL provides consumers and manufacturers with a baseline for comparing the performance of tractors. An unbiased and fair test does not mean that marketing information published by different manufacturers is easy interpreted nor is it conflicting. This occurs because there are many different test runs under different conditions. The NTTL has a very strict policy regarding unbiased testing as the Roger Hoy, Director of the NTTL states "First, the NTTL does not, and will not, endorse any tractor or tractor manufacturer. Our mission is to provide useful, unbiased data in the form of test reports on all tractors that we test."[56] He continues to discuss the importance of viewing a complete test report vice picking out individual data. A tractor may be used in several different capacities, full load which is generally greater than or equal to ninety percent of maximum capacity, or normal conductions, seventy to eighty percent of maximum output, and light loading, anything below sixty percent loading. The most operating time for a tractor is expected to be in the normal load range.[57] Many advertising reports use specific data from maximum runs to illustrate the superiority of their product. Unlike performance data in other industries the NTTL test data provides complete reports to the public. Any potential buyer can compare all data and the conditions under which it was obtained. Manufacturers understand the importance of NTTL reports in the market place. Some manufactures have paid for unofficial tests (see Appendix D) to evaluate their products before submitting for the official test. The Nebraska Tractor Test is a fair and open performance evaluations system.

[55] "Board Action No. 30." 8 March 2007. Nebraska Tractor Test Laboratory, Board Actions. 18 July 2008 <http://tractortestlab.unl.edu/board/ttl_action30.pdf>.

[56] Hoy, Roger M. "Director's Comments." Spring 2010. Nebraska Tractor Test Laboratory. 22 July 2011 <http://tractortestlab.unl.edu/Director2.htm>.

[57] Hoy, Roger M. "Director's Comments." Spring 2010. Nebraska Tractor Test Laboratory. 22 July 2011 <http://tractortestlab.unl.edu/Director2.htm>.

Emerging Standards

As with any developing technology industry there are emerging standards. In agriculture many of the new technologies are not related to tractors specifically but are more related to an entire field know as precision agriculture. "Precision agriculture, also known as site-specific management, addresses spatial variability within a field and how to best manage that variability to maximize production and profitability while minimizing risk. Site-specific management may be applied to such decisions as variety selection, weed and pest management, nutrient management, and irrigation."[58] Many of the new standards include the interoperability of systems which provide variable rate capability for fertilizer application, herbicide application, and seed placement. Another part of precision agriculture is the use of GPS guidance and auto-steer functions. Some of the more global standards being worked on by ASABE are in the field of aquaculture.[59] Aquaculture is the commercial farming of seafood in a controlled environment. With earth's increasing population aquaculture is becoming increasingly important for feeding the world. Aquaculture will need standards dealing with health and environmental concerns. Tractors standards have improved the ability of manufacturers to market their products worldwide meanwhile the same standardization is needed for implements. Many manufacturers wish to distribute their implements globally but currently implements do not have the same standards' infrastructure to support them.[60] Finally, the latest standard development for tractors has come as a result of Tier IV emissions standards. The new emissions standards have required the manufacturers to select one of two primary methods for improving emissions. The first is the use of a Diesel Exhaust Fluid. Since this new product is consumed, future performance test must measure the amount of fluid consumer as a portion of the fuel efficiency test. The other method requires use of regenerating particulate filters must also be evaluated.

Conclusion

Agricultural Tractor standards are intricate and complicated like most others standards in the United States. There is no easy flow chart to describe the unique web of SDOs involved in the process. The OECD has been able to develop a testing standard which includes accreditation of test laboratories and a process for validation of test records. This is different from many of the other worldwide standards

[58] NCSU Crop Science Department, Precision Agriculture . 2011. 22 July 2011 <http://www.cropsci.ncsu.edu/csarea.asp?Subject=Extension&Topic=Precision+Agriculture&Info=Ext_PrecisionAgriculture>.

[59] Tsunemori, Travis. ASABE Technical Services Support Engineer Chad Ingle. 14 July 2011.

[60] Tsunemori, Travis. ASABE Technical Services Support Engineer Chad Ingle. 14 July 2011.

such as ISO who develop manufacturing specifications and quality control measures versus OECD's testing and reports. While ISO aligns international processes and specifications, OECD goes one step further to produce an international test record. By producing standardized performance reports, a product can be easily marketed globally without retesting. The importance of the standardized test in the U.S. cannot be overstated. On a global level the NTTL certifies tractors under the OECDs regulations, but on a national level they provide unbiased test data used by manufacturers and consumers. The production of a complete report on performance and fuel economy across a full range of operating speeds provides potential buyers a true representation of a tractors performance. The development of first-class agricultural tractors standards by multiple accredited SDOs is a result of the following qualities of a good SDO: transparency, openness, impartiality, consensus, due process, effectiveness, and performance based. [61] The cooperation in the U.S. between the public and private sector is another key factor which makes the tractor standards superior. The standards also incorporate academia, industrial market, and consumers in the process. Agricultural Tractor standards did not happen by accident but rather they are the result of a lot of effort by many different people, from different backgrounds, in different locations working for a greater good.

[61] United States Standards Strategy Committee. "United States Standard Strategy." New York: American National Standards Institute, 2010. 6.

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